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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Foundry Apprentices.

The London, Lancashire, and Coventry Branches of the Institution of British Foundrymen have each in turn recently resurrected the problem of getting the best type of lad into the foundry. Throughout these deliberations the word "foundry" has been used in its most restricted sense. It has not included the pattern shop because it has invariably been stated that no difficulty is being experienced in filling pattern-shop vacancies with suitable lads. Now a survey of the foundry managers of the country would probably reveal that an important percentage of these men are "pattern makers by trade." They have taken a keen interest in the moulding and casting aspects of foundry work, and have equipped themselves to take charge of the complete department. These are *true foundrymen*. If, then, it is established that no difficulty exists in getting patternmakers' apprentices and a real difficulty abounds in equipping a foundry with moulders' apprentices, then we suggest in all seriousness that both appellations should immediately cease to exist and only *apprentice-foundrymen* be indentured. We imagine that all sorts of objections can be raised against such a system. Obviously it cannot apply to either outside patternmaking establishments or foundries having no pattern shop. There are objections to be met emanating from persons who will state definitely that the normal period of apprenticeship is insufficient to learn either moulding or patternmaking. This we will grant, and even extend the period to a lifetime, but in doing so we would point out that by such innovations as moulding machines and sand-papering machines and a host of other time-saving devices, the apprentice should be able, having the benefit of a modern education, to learn as much of a trade in three years to-day as he did formerly in seven years, and this in spite of reduced working hours. When a youth decides upon a metallurgical career he is not aware as to whether he will be subsequently engaged in an iron, steel, or non-ferrous works, and so, too, the apprentice-foundryman should not be aware as to whether he will start his real work as a patternmaker, coremaker, or moulder. His object in life, from the inception of his career, should be to become a *true foundryman*. On all sides one hears of the basic necessity of co-operation between drawing office, pattern shop, and foundry, and if apprentices were learning the two trades side by side, the cry should disappear within a decade. After all, a successful foundry manager has to have a working knowledge of both moulding and patternmaking, reinforced by a knowledge of metallurgy.

The result of this proposed scheme would be that the boy, his parents, and the employers would merely start out with the knowledge that efforts were to be made to turn the lad into a foundryman, and the route by which this end shall be accomplished would depend on the curriculum, trade conditions, and the boy's special aptitude.

Another objection the scheme will have to meet is that it would merely provide "a jack of all trades and master of none." This we refute by pointing out that at the end of any even specialised apprenticeship the average boy, if he realised what he has to learn and the potentialities of his job, has done well. After all, the apprentice just out of his time or the technical college graduate knows very little. The latter realises this when he comes into the labour market, for it is not until his training has been backed by works' experience that he is of any real value to his employer. Once the underlying principles are absorbed, their application will probably vary enormously every time he changes his job, and his adaptability will either make or mar his professional career. There are cases where two firms have exactly the same type of output, and experience gained at one can immediately be applied to the other, but even here adaptability will be required owing to differences in method or plant, which cannot be changed in entirety.

Finally our object in putting forward the system of starting out with apprentice foundrymen instead of apprentice patternmakers or moulders is to overcome the difficulty which apparently is associated with "what's in a name?"

Our Birthday Greetings.

Last week, in a leader, we drew attention to the fact that we had reached our majority, and as a result we have received the following congratulatory letters:—

From **Mr. H. L. Reason,** *President of the Institution of British Foundrymen.*

On the twenty-first anniversary of your JOURNAL, the official organ of our Institution, allow me, as President of the Institution of British Foundrymen, to send you our heartiest and best wishes. I have no hesitation in saying that the work of our Institution has been considerably advanced by the publication of our work in your Journal, and the foundry trade of the country owes a debt of gratitude for the knowledge your Journal has dispersed for the benefit of the industry in general.

Your Journal has been considerably improved since its first inception, and the British foundrymen are looking forward to the day when your publication will not only be the premier paper on foundry matters in this country, but in all other countries.

Mr. Oliver Stubbs, *Past-President and President-Elect of the Institution of British Foundrymen, and President of the National Ironfounders Employers' Association.*

It is with much interest and pleasure that I am reminded of the twenty-first anniversary of the publication of THE FOUNDRY TRADE JOURNAL, and have refreshed my memory by looking over Volume I., published on January 16, 1902.

In your introduction you say "The foundry trade has up to the present been sadly neglected in the way of literature of a trade nature devoted specially to its advancement and interest." I feel I am voicing the opinion of all foundrymen when I say THE FOUNDRY TRADE JOURNAL has supplied an excellent medium for the exchange of ideas and experiences.

During the last fourteen years much progress has been made in the foundry trade, due to the educational work which has been carried on by the Institution of British Foundrymen, and as a Past-President of the Institution, I wish to add my appreciation of the very ready manner in which you have lent your Journal for the publication of this work, and trust your Journal will continue to increase in value by bringing before its readers the best means of facilitating and improving the manufacture of castings of all descriptions.

Mr. Robert Buchanan, *First President of the Institution of British Foundrymen.*

I see in this week's issue of THE FOUNDRY TRADE JOURNAL that on January 16 you celebrated the 21st birthday of the JOURNAL.

At the Branch meeting in Manchester on January 13 the able Paper given by Mr. Sherburn mentioned how much the status of foundrymen had improved in the last twenty years. That period covers the work of THE FOUNDRY TRADE JOURNAL and the Institution of British Foundrymen. Their influence on the intellectual and practical sides of founding has been profound and valuable from a national point of view.

I wish to acknowledge the great ability with which the JOURNAL is conducted, and wish for it long life and prosperity.

Mr. F. J. Cook, *Past-President of the Institution of British Foundrymen.*

On THE FOUNDRY TRADE JOURNAL having attained its majority, I take this early opportunity of sending hearty congratulations, and best wishes for its future success. Having been a subscriber from its very inception, I can appreciate both the improvements achieved and the general utility of the paper.

Hoping that "self satisfaction" will never be its watchword, and that it will go on from success to success is my earnest wish.

Mr. Sydney A. Gimson, *Past-President of the Institution of British Foundrymen.*

Hearty congratulations to THE FOUNDRY TRADE JOURNAL on becoming "of age." More than ever will be expected from it now that it has passed through the years of its "callow youth." I have been for so long outside the foundry trade that I have to confess that I now seldom read any technical literature, but I have a very vivid recollection of how valuable THE FOUNDRY TRADE JOURNAL was to me when I was in the business, and I have always been most grateful to it for its invaluable services to the Institute of British Foundrymen. Good luck to you. Go on with the good work you are doing, and increase it as the years go by.

Mr. J. E. Ellis, *Past-President of the Institution of British Foundrymen.*

Please accept my hearty congratulations on the twenty-first birthday of THE FOUNDRY TRADE JOURNAL, and I hope sincerely that it will live long to continue its sphere of sound education by the publication of articles, both practical and scientific. Nor can I forget to mention the good and effective work it rendered to the Association of British Foundrymen, now the Institution of British Foundrymen, at its inception. In the second issue of the JOURNAL, February 16, 1902, a letter was published under the heading: "An Institute of Iron, Steel and Brass Founders. Why Not?" and signed "Foundryman," and the Editor immediately opened the columns of the JOURNAL for the free discussion of the subject, and its columns have been open ever since.

I cannot see how we could have started the Institution of British Foundrymen without the willing and ready help given to us by THE FOUNDRY TRADE JOURNAL, and I feel we owe a deep debt of gratitude for the prolonged and live interest it takes in all the Institution's movements.

You have my thanks and best wishes at all times.

Mr. Thos. H. Firth, *Past-President of the Institution of British Foundrymen.*

Congratulations on the coming of age of your most valuable paper. The progress of the FOUNDRY TRADE JOURNAL marks the advancement in the trade during that period, and I consider every foundryman is under a personal debt to your paper for the manner in which they have from time to time put before their readers the latest practice in all countries. The Head of a Sheffield Research Department recently stated that he found your JOURNAL invaluable for reference in many matters.

There is little doubt that the Institution of British Foundrymen owes a great deal to the encouragement which the Editor of the paper gave them when the scheme was originated. I trust that the next period may show the same good progress in the advancement of foundry knowledge and the prosperity of your publication. With all good wishes.

Mr. John Little, *Past-President of the Institution of British Foundrymen.*

There is no doubt the JOURNAL takes the lead a long way with the subjects to which it devotes its pages. It is very largely used by the managers and foremen connected with the foundry trade. I only wish it was more generally studied by the working members of the trade—for there are tremendous possibilities from such an education. There is no doubt as time goes on the men who comprise the foundry trade of this country will be a different class of men from those who have been employees in the past. I always regarded a good foundryman as one of the most skilful men in the engineering trade, and it was always a marvel to me the technical ignorance a great number of them displayed at their own work. I think a closer study of the JOURNAL you refer to would do much to remove this stigma.

Belgian Locomotives for Poland.—The Polish railways have placed orders for 100 locomotives with the following five Belgian concerns:—Cockerill, St. Léonard, Ateliers Métallurgique, Forges et Usines de Haine-Saint-Pierre and Société Franco-Belge de Matériel de Chemins de Fer. Arrangements have also been made for erecting locomotive shops in Poland. The plans are to be prepared by Belgian engineers in consultation with the Polish railway authorities.

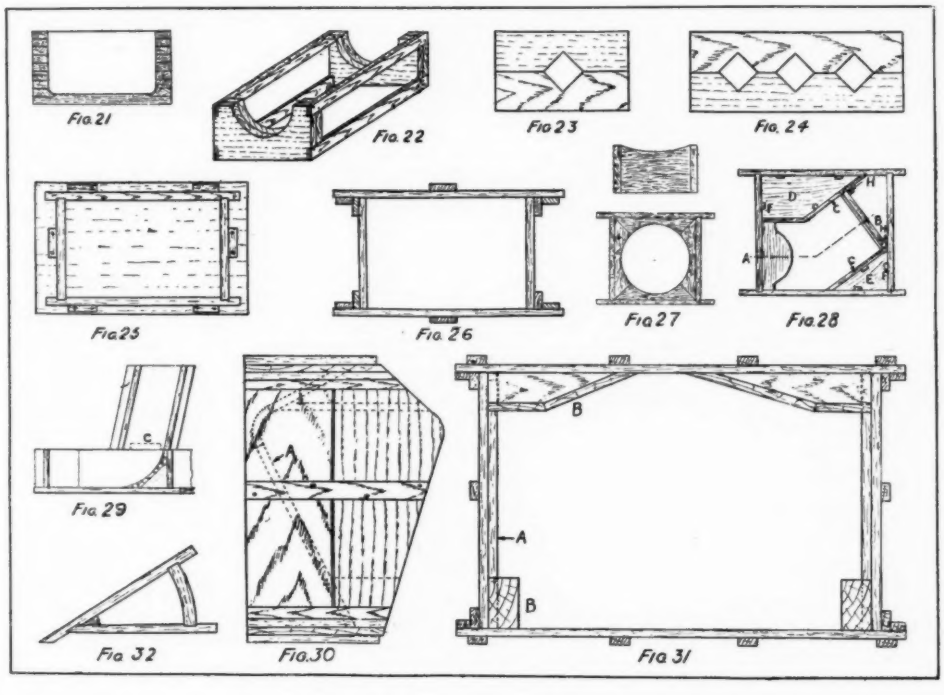
An Apprenticeship Course in Foundry Practice.—XXVII.

By Ben Shaw and James Edgar.

THE CONSTRUCTION OF CORE-BOXES. Part III.

Core-Boxes for Cylindrical Cores.

It should be clearly understood that in these articles on core-boxes the relative merits of core-boxes as compared with core-frames and plates are not discussed. For one-off jobs core-frames are in many cases satisfactory, and, in some instances, when a number of cores are required, a core-frame or plate may be a more practical as well as a more economical way of obtaining a core than with a core-box. When determining the construction of core-boxes or frames the pattern-maker must have an understanding of foundry practice. For instance, overhanging parts should be avoided in core-boxes whenever possible. It is frequently necessary in order to prevent this to print underneath a bracket or rib in a core-box and make a special core-box to form a core that is afterwards located in the main core.



In the last article on core-boxes we dealt chiefly with cylindrical cores, and before leaving these we shall describe two other forms of construction. Fig. 21 illustrates a satisfactory method of making a medium-sized core-box when the shape is not more in length than, say, two-thirds of its diameter. If considerable taper could be allowed it would be quite permissible to make a deeper box in this way. It is a useful type of box for a thin metal job because any change that may take place will be uniform all round the diameter and will be small. Attention may be drawn to the method of setting the first course of segments into a check turned on the bottom plate. A core-box made like this, if made of baywood, is practically indestructible, but if the job will not bear the additional cost of this timber, yellow pine may be used for all but the top course which, if made of baywood, will retain a sharp edge.

Fig. 22 shows the best method of constructing a box for a large cylindrical core or even a medium-sized cylindrical core which is long. Such a box should always be built, lagging being fitted to a framework consisting of grounds and distance-stays. The method sometimes practised of fixing semi-circular grounds on a building board and fitting staves or lags over them after which supports or grounds are fitted over the lagging is both clumsy, unpractical, and inaccurate. The grounds should be made of crossed thicknesses, if many cores are required, and not less than 2½ in. thick. The stays may be 2½ to 4½ in. wide, according to the size of the work, and 1¾ or 2 in. thick. The core-box should be built just slightly longer than the finished length of the core in order that it can be cleaned up when the lagging has been fixed. The inside of the box has to be planned out finally to the core diameter. There is no danger of the framework becoming twisted if reasonable care is exercised when cutting the various checks. The grounds should be screwed together before being cut to shape, and the distance between the grounds should be 18 in. or less.

It is quite common practice, even with first-class work, when a full cylindrical core is wanted to make a half core-box from which half cores are made and afterwards pasted together, or, alternatively, to screw ends on the core-box the top parts of which are semi-circular and on which a strickle to form the top half of the core can ride.

Square and Rectangular Cores.

In all pattern-shops boxes for large and small rectangular cores are made, and, generally speaking, they do not present much difficulty. With very small cores it is best to make a box like Fig. 23, making a diagonal joint, because the core is more easily removed from such a box. It is the usual practice when many cores are required to make a multiple box like Fig. 24, and sometimes metal boxes are provided in such cases.

Only the smallest boxes can be made in the way just described. Thin slab cores may be cut from a thickness of hardwood, but the great majority of square and rectangular cores are made in framed core-boxes similar to Fig. 7 in Part XV. of this series (Cores and Core-making). The thickness of timber for framed core-boxes should be from 1 to 1½ in., depending on the size of the box. Cheese-headed screws with washers are very suitable for framed core-boxes which the

core-maker has to take to pieces. A bottom may be an advantage or it may be a disadvantage. If the box has no bottom the core-maker can make the core direct on a plate and all the wood-work can be removed before the core is transferred to an oven to be dried. Often, however, bosses and ribs have to be fastened to a bottom. With other than the smallest boxes, bottoms should not be screwed from the under-side but by blocks about 1½ sq. and about 4 in. long—buttons they are sometimes called—which are secured to the bottom, the sides and ends of the box, as in Fig 25. This obviates the trouble of removing bottom screws when stripping the core.

Very large and deep-framed boxes are made somewhat differently from small boxes. It may be necessary to make up the sides of two or three different widths battened together. A plan of a suitable construction is shown at Fig. 26. It will be observed that the end-battens of the sides are screwed on the inside and serve the same purpose as checks on smaller boxes.

Boxes for Irregular Shapes.

It is sometimes very convenient when making boxes for irregular shaped cores to make a frame and fill in with shaped blocks. It is also done sometimes when making boxes for cylindrical cores about a foot diameter with an end-fitting on a circular body. The construction of such a box is made apparent at Fig. 27. Sometimes instead of filling-in, the sides are made thicker and shaped. A very good example of filled-in frames are core-boxes for the weight or wyper shaft-bracket shown at Figs. 12 and 13 in Part XXII. One of these boxes is shown in Figs. 28 and 29. A bottom is almost necessary, and if the shape of the core is set out on the bottom, the filling-in blocks D, C and E will be defined. They may be made of top and bottom plates with stays F set into them with a shoulder. The faces may be ¾ or 1 in. thick. If very large, the bearing would be boxed, but in the sketch it is shown as a solid block, and at the opposite end of the box a square end may be fitted between the sides CC, blocks HH being fastened to the sides to define its position. This is a box which is easily stripped from the core.

It often happens, especially in patternshops where large work is made, that, while it is not impossible to make wood construction inside a frame to define the shape, it would be very costly to do so and the box would be clumsy to handle in the foundry. The method may then be adopted of fitting guide strips—sometimes termed runners—inside a square frame and providing the core-maker with a straight-edged strickle for forming a sand bottom. An example of this kind is shown at Figs. 30 and 31 which is a core-box for a condenser. The outer frame is built as previously explained, the ends being shaped, AA represent the strips about 1 in. thick and BBBB, Fig. 31, are boxed-up blocks. These blocks bed on to the sand bottom and are taken out when it is being strickled. Many difficulties in connection with large core-boxes are surmounted in this way.

Sectional Boxes.

The cores for many circular castings are made in sections. Ribs may determine whether the sectional core-box shall be a sixth or an eighth, or the diameter may be the determining factor. Even when the centre boss is of fairly large diameter, it is always better to make the box to the centre as shown at Fig. 32, as it is the more easily altered, and bosses, ribs, etc., can be set more easily because the centre is on the box. The circular part in the case of large boxes should be built segmentally. It is frequently necessary to shape the top of a core like this, and it may be done by means of a strickle swinging from a centre dowel and resting on the circular part of the box, the sides being shaped by the strickle.

Reports are current in Toronto that Messrs. William Jessop & Sons, the well-known steel manufacturers of Sheffield, are preparing to erect a branch factory at some point in Canada. Inquiry at the Toronto office of the concern has failed to elicit definite information.

Some Notes on Semi-Steel.

By NEVILLE DEANE.

Much has been written concerning this subject—in fact, perhaps so much that the average foundryman is somewhat confused as to which to believe of so many varied opinions. The object of these notes is to explain the principles underlying the production of semi-steel.

Firstly, the introduction of steel will produce a cast iron having smaller and more evenly distributed flakes of graphite, and consequently a stronger material, without necessarily lowering the carbon content. Secondly, the steel may be melted into the cast iron for the purpose of decreasing the carbon content; or it may be desired to achieve either of these results.

Dealing with the first object, the iron and steel must be melted together in a cupola in presence of a slight excess of coke. The air blast should be "soft," but by no means insufficient in volume. The steel will then be in a suitable condition to take up carbon from the coke, to the saturation.

In working out charges of semi-steel for this method, very serious consideration must be given to the fact that the product is a cast iron, influenced by the content of silicon, sulphur, phosphorus and manganese, exactly as are other cast irons.

For example, assuming that castings have been fairly satisfactory in an ordinary iron containing silicon 2.5, phosphorus 1.0, sulphur 0.1, and manganese 0.5 per cent., and it is desired to make similar castings of a stronger material, and it is decided to use a 50 per cent. semi-steel mixture. It should be clearly understoood that the pig-iron mixture used must also be radically altered, so that the final semi-steel product has the same silicon, phosphorus, sulphur, and manganese content as the ordinary grey-iron castings. If the same mixture of pig-iron is used in combination with 50 per cent. of steel scrap, the silicon in the castings would be decreased to about 1.25 per cent. and the phosphorus to about 0.5 per cent., and the almost inevitable result would be an insufficiently-fluid iron, and hard, unmachinable castings. Semi-steel should not be any higher in combined carbon than similar ordinary grey-iron castings, but should merely be of a closer grain, due to the smaller size and difference in distribution of the graphite flakes.

The silicon and other elements can be varied to suit the action, strength, or fluidity required, exactly as in the case of ordinary iron castings, so that the pig-iron used may range from the poorest cinder pig to the dearest hematite.

Dealing with the second effect obtainable by the use of steel, namely, the reduction of the total carbon, it can be at once mentioned that the carbon content cannot be lowered much below 2.5 per cent., the figure depending upon the section of the casting. Obviously in two similar castings of the same combined carbon, the one having the lower total—and therefore lower graphitic-carbon—will be the stronger and tougher.

This class of semi-steel can only be made in a satisfactory manner in an air or open-hearth type of furnace, and is consequently hardly applicable to general purposes. It is, however, particularly useful for rolls, etc., and also for the production of the finest quality of malleable castings. The wonderful results obtained with American malleable cast iron are on the basis of a reduction of the total carbon to the lowest possible limit by means of steel scrap. It should be mentioned that a higher silicon-content is allowable in a lower total-carbon cast iron than in a higher total-carbon cast iron in order to produce an equal quantity of combined carbon in each. This is an advantage in the production of malleable castings, owing to the influence of the increased silicon on the ease and certainty with which the combined carbon is transformed to temper carbon in the annealing process.

In conclusion, it may be confidently stated that, provided due consideration is given to the correct analysis of the pig-irons used, semi-steel will undoubtedly give a stronger as well as a possibly cheaper casting than will ordinary cast iron. It is hoped that these few notes will give an indication of the proper way to proceed in order to achieve the best results.

An Investigation of Duralumin.*

By Seibei Konno.

Introduction.

Among the light alloys, the best is an aluminium alloy known as "duralumin." It was discovered by Alfred Wilm during the years 1903-11, in Germany, and, in 1911, he published the remarkable results of his investigation. The following is a brief summary of his results:—In aluminium alloys containing a small quantity of magnesium the hardness decreases temporarily by quenching, but increases with lapse of time. The increase due to this ageing is very rapid at first, and then gradually becomes slow, while in the case of carbon steel, the quenching increases the hardness, but decreases the ductility; in the former alloys it increases both the hardness and ductility, so that the ultimate strength of the alloys is improved by cold working after quenching, when great ductility is not required. If a certain amount of copper is added to the alloys of Al-Mg described above, their strength and hardness increase in a considerable degree, and the quenching produces a similar effect to that in the case of alloys containing magnesium only. A further addition of manganese to the above alloys results in an increase of hardness, but an addition of nickel produces an increase of viscosity. These duralumin alloys are known under the name of "duralumin." A. Wilm also examined the microstructure of quenched duralumin to determine the change accompanying the quenching and ageing, but he could not discover any such change.

Afterwards some investigations were made by L. M. Cohn, and more recently by P. D. Merica, R. G. Waltenberg, and H. Scott. The latter investigators made experiments on the quenching effect in various conditions, in order to ascertain whether the quenching, as described by Wilm, actually produces good mechanical properties in duralumin, or not, and put forward a theory for the mechanism of the ageing effect. According to this theory, this effect is due to the gradual precipitation of the compound $CuAl_2$, which is held in solid solution by quenching. Z. Jeffries supported this theory by introducing his idea of the adhesion and the cohesion.

Thus far we have a number of experiments for the mechanical properties of duralumin, but only a few experiments for the physical properties, a complete knowledge of which is very useful for the elucidation of the ageing effect of that alloy. Hence, in the present investigation, stress was mainly laid on the measurements of electric resistance, thermal expansion during heating and cooling of duralumin or similar alloys. The measurements of the mechanical properties were also made by an Olsen testing machine. The following abstract contains the method and the results of the present investigation.

Preparation of Duralumin.

Composition and Mechanical Properties.—Duralumin is commonly used in the worked state in the form of plates, tubes and wires. Its composition and mechanical properties lie in the following ranges:—

Composition:—3.0-4.5 Cu, 0.4-1.0 Mg, 0.0-0.7 Mn, 0.4-1.0 Fe as impurity, 0.3-0.6 Si as impurity, and the rest being Al. Sometimes in addition to the above there is 1.5 to 2.0 per cent. Zn.

The mechanical properties of rolled and heat-treated commercial alloys are:—Tensile strength, 23-25.5 tons per sq. in.; elastic limit, 12.5-15; elongation, 15-20 per cent.; reduction of area, 35-38 per cent.; Brinell hardness, 98-120.

The density of the alloys is about 2.85, and their melting point is about 640 deg. C.

Casting.—A quantity of aluminium was first melted in a graphite crucible heated in a gas furnace, and then a certain amount of copper and manganese was introduced into the melt by the addition of a suitable quantity of two alloys previously made, one containing 50 per cent. of copper and 50 per cent. of aluminium, and the other 10 per cent. of manganese and 90 per cent. of aluminium, and the mixture was well stirred with an iron or carbon rod. When the copper and manganese had gone into solution, the heating gas was stopped and the melt cooled to a temperature of about 700 deg.; it was then stirred with a stirrer, formed of a piece of metallic magnesium bound with an aluminium wire at the end, which was quickly immersed into it. The melt was again heated, and stirred from time to time to get a uniform solution; the crucible was then removed from the furnace and cooled to the casting temperature of about 700 to 680 deg., and poured into an iron mould. Special care was taken that the maximum temperature during melting did not exceed 850 deg., as in the founding of aluminium alloys heating over 850 deg. C., or a very long heating at somewhat lower temperatures, causes the casting to be more porous.

Working.—As the laboratory has at present no equipment for rolling, the working of the alloy has been always done by hammering and drawing. From these tests, and also the results of the experiments described later on, the present writer concluded that the best annealing temperature is the range from 300 to 350 deg. C., and the best temperature for hot working lies probably in the same range.

Results of Tensile Tests.—The tensile tests were made on both cast and hammered samples (linear reduction about 30 per cent.) having various compositions of 3-4 per cent. copper, 0.5-1.0 per cent. magnesium, 0-0.5 per cent. manganese, and the rest aluminium. Sometimes other elements were further added.

From the tests taken it was found that the average tensile strength is as follows:—

Cast Specimen.—Tensile strength, 10.1 tons per sq. in.; elongation, 3 per cent. on 2 in.

Hammered, Quenched and Aged Specimen.—Tensile strength, 24.1 tons per sq. in.; elongation, 7 per cent. on 2 in.

In the latter case the results are irregular; this is probably due to the cracking or the heterogeneity caused by hammering.

Effects of Quenching and Ageing in the Mechanical Properties of Duralumin.

Effect of Quenching Temperature.—Six specimens were taken from the hammered piece used in the tensile test for the measurement of hardness. They were at first normalised by heating at 500-520 deg. C. for about 20 min. in an electric furnace, and then cooled in the furnace. Each specimen was then heated at the temperatures ranging from 550 to 300 deg. C., and at every temperature, after keeping it constant for about 30 min., was quenched in water. The hardness of each specimen was determined by a Brinell hardness tester immediately after quenching, and also from time to time during the ageing for several days.

Next, five specimens of the same material as described above were heated at 500 deg. for 20 min., and one of them was directly quenched in water, and the remaining four were quenched in the same bath, when they were cooled to the temperatures of 470, 400, 300, and 230 deg. respectively. According to the above results, the immediate effect of quenching is always very small, but the ageing effect after quenching is relatively large, the maximum final hardness being given by quenching the specimen from 500 deg. in water. Notwithstanding the quenching from the same temperature, the hardness obtained during cooling from 500 deg. is always greater than that obtained during heating from room temperature. Hence, in practice, the quenching effect of duralumin is not greatly diminished by a slight depression of the quenching temperature during the operation, provided the specimen is heated to 500 deg. for a sufficient time. From the above results we conclude that the transformation in duralumin takes place very slowly, so that the partial suppression of the transformation occurs at an ordinary rate of cooling. Hence even the normalised specimen as described above

* Abstracted from the Science Reports of the Tohoku Imperial University.

has also a small quantity of quenched transformation, and the complete tempering takes place only when the specimen is heated sufficiently long in the vicinity of 350 deg. The minimum hardness at 350 deg. is due to the tempering effect.

If the above view be correct, the hardness of the quenched specimen during cooling, if exposed for a sufficient time at the quenching temperatures, must necessarily coincide above 350 deg. with that during heating.

Quenching Liquid and its Temperature.—The change of hardness by quenching from 500 deg. in water at different temperatures, such as 20, 50, and 100 deg., was measured. The specimens used were the same as those in the preceding section. From the results obtained in this experiment it is to be noted that, with the rise of the temperature of the water bath, the immediate effect of quenching increases, but the amount and the duration of ageing effect decrease, the final hardness becoming smaller.

Other experiments showed that the ageing effect from oil quenching is always less than that in water quenching, and that if the temperature of oil is higher than 100 deg., the ageing effect almost disappears. The immediate effect of quenching in oil is always greater than that of quenching in water.

To sum up the above results, the harder the quenching the smaller the immediate effect, but the greater the ageing effect. Similar phenomena are also observable in the case of low-carbon steels.

Effect of Forging on Ageing.—Specimens taken from a chill casting having the composition 3.5 Cu, 0.5 Mg, 0.5 Mn, and the balance Al, showed that the ageing effect in a cast condition is smaller than that in a forged condition.

Effect of Quenching on Tensile Strength.—It is evident that the effect of quenching on the tensile strength of duralumin is the same as that on the hardness.

Effects of Quenching and Ageing on the Physical Properties of Duralumin.

Effect of Quenching on Specific Electric Resistance.—The specific resistances of duralumin under various heat-treatments were measured with a potentiometer. The specimen used was a wire, about 2 mm. dia., having the following composition:—

4.0 Cu; 0.7 Mg; 0.5 Mn; and the rest Al.

From the results obtained it was found that the change in the specific resistance of duralumin produced by quenching is similar to the change in the hardness, and that the immediate effect of quenching is greater, but the ageing effect smaller, than is the case with the hardness. This is probably due to the severe strain on the wire.

Under this section the author also deals with the effect of quenching and annealing temperatures on the specific resistance; change of specific resistance during heating or cooling; thermal expansion of quenched duralumin; and change of length accompanying the ageing of quenched duralumin.

X-ray photographs show no difference in duralumin due to the effect of ageing. The microscope, too, failed to find any change in structure due to ageing.

Hardening of Duralumin.

Change of Specific Resistance of Duralumin, due to Tempering.—The specific resistance of quenched duralumin changes abnormally in two steps at about 210 and 280 deg. C. To investigate the cause of this abnormality, experiments exactly similar to those described were made on various specimens of the alloys of Al-Cu and Al-Mg. It was observed that the abnormal change due to tempering takes place in one step in every heating curve. The temperature of the abnormal change slightly falls with the content of copper or magnesium content, but for the alloy with 4 per cent. of copper is about 310 deg., and for the alloy with 0.5 per cent. of magnesium about 240 deg. Hence we conclude that the first step in the tempering curve of duralumin is due to magnesium, and the second step to copper. The tempering temperatures in duralumin are, however, slightly lower than those of the above alloys containing copper or magnesium. This difference is probably due to the mutual action of these elements.

The abnormal change in alloys due to tempering reaches a maximum at about 0.5 per cent. of magnesium, and decreases with a further addition of magnesium, the effect almost vanishing at 5 per cent. of magnesium. Hence, the cause of the quenching effect in Al-Mg alloys is not merely due to magnesium, but to a compound of magnesium with silicon, which is always present in aluminium as an impurity. In order to decide this point, the same experiments with various ternary alloys containing magnesium and silicon were made.

Specific Resistance of Al-Mg-Si Alloys and their Quenching Effect.—With the various alloys of the aluminium corner in the system Al-Mg-Si, the same experiments as described above were made. Silicon was added in the form of crystalline silicon (95 per cent. Si). It was found that the quenching effect of these ternary alloys is due to the presence of a certain percentage of silicon and magnesium, and if the quantity of magnesium exceeds a value depending on the quantity of silicon, the quenching effect diminishes and at last vanishes, but even in the alloys containing 5 per cent. of magnesium, if the silicon content increases to about 3 per cent., the quenching effect becomes very prominent.

The addition of an increasing amount of silicon to the alloys, which contain a comparatively large amount of magnesium, and hence a high resistivity, causes their specific resistance gradually to decrease, and at last to become nearly constant.

From the above results the following conclusions may be deduced:—The quenching effect of Al-Mg alloys is chiefly attributable to a compound Mg_2Si, the solubility of which in aluminium increases with the rise of temperature. Silicon is always present in aluminium in a small quantity as an impurity. The decrease of the quenching effect of the Al-Mg alloys in the high percentages of magnesium to dissolve in aluminium, and hence the solubility at high temperatures of the compound; for the excess of magnesium combines with aluminium to form the compound Mg_4Al_3, and dissolves in aluminium. Thus the solubility of Mg_2Si in an alloy containing an excess of magnesium, such as 5 per cent. Mg, almost vanishes, and hence the quenching effect disappears. The increase of the specific resistance is small up to about 1 per cent. of magnesium. A further increase of magnesium causes the excess of magnesium to disolve in aluminium, and hence the specific resistance increases rapidly with the content of magnesium. Similarly, in the other two series of alloys, with 0.5 and 1.0 per cent. of silicon added, the increase of the specific resistance is small up to about 2 and 3 per cent. of magnesium respectively, which are the quantities required to combine with silicon, but with a further increase of magnesium, the specific resistance of the alloys increases rapidly.

Moreover, in the alloys containing an excess of magnesium, the specific resistance must decrease by adding silicon to the alloys, because the addition of silicon increases the quantity of Mg_2Si, which is insoluble in aluminium at an ordinary temperature, and consequently causes the decrease of magnesium forming the solid solution with aluminium.

Hardness of the Alloys Al-Mg and Al-Mg-Si.

Generally speaking, the formation of a solid solution or a compound in the alloys causes a considerable increase in their hardness, and the decomposition of these phases a decrease in their hardness. Hence, in order to confirm the above results, the writer made five specimens of Al-Mg alloys containing 0.2, 0.5, 1.0, 2.0 and 5.0 per cent. of magnesium respectively, silicon content entering as an impurity being 0.6 per cent. The Brinell hardness of these specimens was first measured in the annealed state; then these specimens were quenched at 500 deg. in water, and their hardness was measured during the time of ageing.

Next, to determine the influence of silicon on the hardness, two series of the alloys Al-Mg-Si containing 0.5 and 1.0 per cent. of Si were made. The Brinell hardness of these specimens was measured both in the annealed and quenched states.

Lastly, the effect of the quenching temperature was investigated; the five specimens of Al-Mg previously annealed were heated at the temperatures of 300, 350, 400 and 450 deg. for 20 min. and quenched in water; then the hardness of these specimens was measured during the time of ageing. In all these alloys the quenching and ageing effect are very small up to about 400 deg., but in the alloys containing less than 2 per cent. of magnesium, the quenching slightly diminishes their hardness at about 400 deg. From a quenching temperature of 450 deg. upwards, however, the hardness and the ageing effect begin to increase rapidly, and are very large.

The above effects of quenching and ageing are exactly similar to those in duralumin. There is, however, a quantitative difference between them; in the case of duralumin, the minimum due to tempering is about 350 deg., and an appreciable quenching effect is produced at 400 deg., while in the Al-Mg alloys these temperatures are 400 deg. and 450 deg. respectively.

Hardness of the Alloys Al-Cu, Al-Cu-Mg and Al-Cu-Mg-Mn.

First, the aluminium alloys containing 2, 4, 6, 10 and 20 per cent. of copper were made, and the effects of quenching at 500 deg. determined. It was found that the quenching effect on hardness increases at first rapidly and then somewhat slowly, as the content of copper increases.

In the above alloys containing less than 6 per cent. of copper the ageing effect is very small; hence the great effect of ageing in duralumin cannot be explained as an influence of the compound Al_2Cu, as has been suggested.

Next, to investigate the influence of manganese on the ternary alloys of Al-Cu-Mg, three alloys having a ternary composition of 4 per cent. Cu, 0.7 per cent. Mg and the rest Al, with the addition of 0, 0.2 and 0.5 per cent. of manganese were made. Their hardness, after quenching from 300, 350, 400, 450, 500 to 550 deg. was measured. The results showed the initial effect of quenching increases with the addition of manganese, but the ageing effect does not change appreciably. The addition of manganese to the ternary alloys does not appreciably alter the relation of the hardness to the quenching temperature; hence, the ageing effect in these alloys is to be attributed to the presence of copper and magnesium.

The author finally deals with a theory of the hardening of duralumin based on a theory analogous to that sometimes used to explain the hardening of steel, which assumes a hard gamma condition. Mr. Konno does not agree with Dr. Rosenhain's views.

Summary.

The results of the present investigation may be summarised as follows:—

1. In quenched duralumin, the softer the quenching, the more the immediate effect of hardening increases, and its ageing effect, as well as its final hardness, decreases. In a quenching in oil at 100 deg. or at higher temperatures, the ageing effect vanishes. On the other hand, the harder the quenching, the more the immediate effect decreases, and the ageing effect and the final hardness increase, their maximum values being obtained by quenching the alloy from 500 deg. in water.

2. The above effect of quenching is due to the dissolution of Cu and Mg compounds in Al, the process of dissolution or separation being very slow. Thus duralumin is in a somewhat hardened state, even if it is cooled very slowly from 500 deg.; perfect annealing is only obtained by heating the alloy at 350 deg. for one hour or more.

3. The quenching effects on the specific electric resistance of duralumin are very great and exactly similar to those on the hardness. Hence, the specific resistance measurement is the most suitable method for the investigation of the hardening of duralumin.

4. The alloys of Al-Cu show by quenching an immediate effect of hardening, but the effect of ageing only very slightly. Hence, the immediate effect is partly due to the dissolution of Al_2Cu in aluminium, but the principal cause of the ageing effect of duralumin is not attributable to that compound.

5. In the alloys of Al-Mg which contain about 1 per cent. of magnesium, the immediate effect of quenching is always very small, but the ageing effect is as great as that of duralumin.

6. The ageing effect, as well as the immediate effect of quenching the above alloys, are attributable to the dissolution of Mg_2Si in Al, but not of metallic magnesium; because, if magnesium increases beyond 1 per cent., the above two effects begin to diminish, and with an increase of above 3 per cent. of magnesium, almost vanish; but an addition of both magnesium and silicon in the proportion of the compound Mg_2Si increases the same effects. A small quantity of silicon is always present in aluminium as an impurity.

7. The further addition of about 4 per cent. of copper and a small quantity of manganese (up to about 0.5 per cent.) to the alloys of Al-Mg. increases the hardness, but not the ageing effect. This alloy usually called duralumin has thus nearly the same ageing effect as the alloys of Al-Mg.

8. From the specific resistance-temperature curves for quenched duralumin we conclude that a quenched alloy is tempered at two steps, beginning at 210 and 280 deg. respectively. The first step in the curves is due to the partial separation of Al_2Cu, and the second to that of Mg_2Si.

9. The quenched duralumin expands at room temperature, as the ageing proceeds, as in quenched low carbon steels.

10. The above effect of quenching and the accompanying change in the physical properties of duralumin are exactly similar to those in severely quenched carbon steels. Hence, we can easily explain the hardening of duralumin by Professor K. Honda's theory of the hardening of steels.

Publications Received.

"COLEMAN OVEN FOR CORES AND MOULDS." This brochure has been sent us by Mr. C. Morehead, care Messrs. E. T. White and Company, 1, Albemarle Street, W.1., the British Representative of the Foundry Equipment Company, of Cleveland, Ohio. The pamphlet describes in a very interesting manner a series of core and mould drying ovens, together with such auxiliary appliances as racks, suspension trolleys, and the like. The illustrations of installations in American foundries are very instructive for British foundrymen.

PASTES AND ADHESIVES SOLUBLE IN COLD WATER.—A four-page pamphlet dealing with adhesives generally has been sent us by Messrs. Nieuwhof, Surie & Company, Limited, of 5, Lloyd's Avenue, London, E.C.3, whose factory is at Groningen, Holland. They claim that one of their brands, No. 2 Scholten-Sichel Rapid Adhesive, Quality R., replaces fish glues. If so, the material should have interest for patternmakers.

Australian Bounty on Iron and Steel.—The Iron and Steel Products Bounty Act, 1922, assented to on October 18, 1922, authorises the Governor-General of Australia to pay bounty, under certain prescribed conditions, at the rates specified below on fencing wire, galvanised sheets, and wire netting manufactured in the Commonwealth and delivered from the works on or after September 14, 1922. Section 4 (2) of the Act provides that no bounty shall be paid on the products in question if they are not manufactured from materials produced or manufactured in Australia, unless, in the opinion of the Minister of Trade and Customs, subject to the approval of Parliament, the use of materials produced or manufactured elsewhere is warranted. Section 8 provides that if, after inquiry by the Tariff Board, the Minister is of opinion that the manufacturer of any goods on which bounty is payable under this Act is not selling those goods at a reasonable price, or that his profits exceed 15 per cent. on the capital employed in respect of the business in connection with which bounty is payable, the Minister may withhold payment of the bounty or part thereof. The total amount of bounty authorised to be paid under this Act, in any one financial year, shall not exceed £250,000. The schedule of bounties is as follows:—Fencing wire, £2 12s. per ton; galvanised sheets, £2 12s. per ton; wire netting, £3 8s. per ton.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

A Discussion on Machine Moulding.

The meeting held on December 15 was undoubtedly one of the most interesting and instructive in the history of the Branch, inasmuch as several types of moulding machines containing the latest inventions were described by experts. Dr. T. Swinden, Branch-President, was in the chair.

THE PRESIDENT, in opening, said they had present four makers of moulding machines, who had been invited to attend for the purpose of giving a description of the particular types of machine in which they were interested, and wished to discuss with the members of the Association.

The representatives were Mr. Daniel Sharpe, of the Foundry Plant and Machinery Company, Limited, Glasgow; Mr. F. E. Steele, representing Messrs. John Macdonald & Son, Limited, Mary Hill, Glasgow; Mr. F. Shearman, representing the Adaptable Moulding Machine Company, Birmingham; and Mr. W. Rawlinson, representing Messrs. J. W. Jackman & Company, Limited, Manchester.

The meeting had, continued the President, some element of novelty in it, for the gentlemen named would not only describe their various types of machine, but a discussion would follow. They would have an opportunity of asking questions or of contributing to the discussion by way of expressing what their experience had been with regard to these particular machines or any other. It was understood that each representative was left perfectly free to talk about just what he wished.

Sand-Throwing Machines.

MR. D. SHARPE, the first speaker, dealt with the Beardsley-Piper sand-slinger machine, his remarks being profusely illustrated by photographs and slides, as were the other Papers. It was desirable, he said, that some definition might be adopted in opening a discussion as to what the functions of moulding machines included and suggested. Principles of moulding consisted of packing sand in a homogeneous mass sufficiently rammed to retain the liquid metal, later to be poured into the spaces left by the pattern and cores, while at the same time it was important that all air contained in these spaces should be free to escape, and also that gases formed in the sand mass by the sudden change of atmosphere have means of escape other than through the face of the mould. The ramming of this mass of sand should be uniform, and any tendency to forming strata should be eliminated. The sand should be used in as dry a condition as possible consistent with a good binding body, which would not easily wash or waste away on the inrush of metal. Hand ramming could give these various conditions when applied by a highly-skilled rammer who sets out whole-heartedly to do so. His progress was necessarily slow, and various methods of producing these conditions by mechanical means had been applied, all of which showed great improvement in speed of production, and some had shown very satisfactory results in the physical conditions of the sand. The following methods of ramming existed:—Pneumatic ramming by air-driven rammers; pneumatic and electric jar ramming; hydraulic pressure ramming, and roller ramming. There was now introduced a new system which had been named very appropriately "sand throwing." It was this latter system he wished to speak about. The principle aimed at was to collect a small wad of sand, compress it, and discharge it directly into the moulding box with such velocity that it packed firmly; other wads were discharged on top, and so on until the flask was filled and the pattern ready to draw. This had been accomplished in a very simple, efficient, and economical manner, and the views he showed illus-illustrated the method of application. The machine could ram anything that came within a 9 ft. or 11 ft. radius, according to the class of work to be made. This machine did not require deep or expensive pits and heavy foundations, nor did it shake the shop with earthquake violence, racking moulds, breaking cores, and, incidentally, the machine itself. It was mobile, required practically no fixing, filled the box and rammed the sand, and left the box and pattern at rest. The tractor-type machine travelled into the sand heap under its own power, collecting the sand from the floor by means of a right- and left-hand sand-cutting screw-conveyor, which conveyed the sand to the centre of the machine, where it was elevated by means of a bucket elevator, and deposited on to the screen of an oscillating riddle. The riddle was so constructed that scrap, gaggers, cores, etc., which were in the sand would stay on top of the screen and work to the front end, where they were deposited into the scrap box, which was mounted on the main arm. The riddled sand was conveyed by the oscillating riddle into a hopper mounted on the impeller arm, above a belt that conveyed the sand into the impelling head, which discharged the sand with centrifugal force into the mould at the rate of 10 cub. ft. of rammed sand per min.

The "Standard Tractor" was known as a 9-ft. machine; that was, it would work into a sand heap that was 9 ft. wide. A labourer could be taught to operate the machine in a few hours, as its operation was so simple. The stationary machine had the same ramming capacity as the tractor type, and was adapted for use in foundries having a sand-conveying system, or where auxiliary equipment was installed to supply sand to the machine. The locomotive-type consisted of the stationary-type mounted on a truck, on which a large sand container was also mounted. The sand could be fed into the container by grab buckets from floor or other suitable arrangement, and the truck moved up the foundry to deal with machines or flasks on either side of the track. The stationary and tractor types also operated on small castings in conjunction with a turn-table set within the radius of the arm, to produce moulds from an unbroken stream of sand, and with a consistent and calculable output.

The Ajax Machine.

MR. F. E. STEELE then described the "Ajax" Jar Ramming machines of the plain and turnover type, of which a number of slides were shown. He said he believed most of those present were aware of the method of ramming by this type of machine, and approximately 90 per cent. of the moulds made could do without venting, because, the sand being rammed in layers, the gases during casting escaped between those layers, and the moulds being more uniformly rammed, better castings were the result. Slides were then shown of the large sizes of machines, together with a number of moulds he had made upon them. To show the quantity of sand that could be rammed per minute, a mould was then shown measuring 9 ft. long by 7 ft. 10½ in. wide by 22 in. deep. This was rammed by 60 jolts, and most of their machines gave 120 to 140 jolts per minute. Many people were doubtful of making flat tops successfully on a jarring machine, and in order that such cause for anxiety might be dispelled, Mr. Steele showed photographs of a mould 6 ft. 1 in. × 5 ft. 7 in. × 7 in. deep, the bottom part of which was made by himself and a labourer in 20 min. The top part was made in 25 min., without the aid of any gaggers or lifters. The casting itself was then shown, this being a 5 ft. sq. plate. He then illustrated a machine with a table 13 ft. long × 3 ft. wide, which he believed was amongst the largest in this country. On this particular machine he, with the assistance of a labourer, produced two complete moulds of a standard street lamp-post in one hour.

THE PRESIDENT, speaking on behalf of the members, said how much obliged they were to Mr. Steele for the description he had given them.

The Adaptable Machine.

The Adaptable Moulding Machine Company's representative, MR. F. E. SHEARMAN, was then called upon to show slides of the various machines manufactured by his Company. These were of the hand-ram type and of a different class from those shown by the other speakers.

The first slide gave the design of the well-known Adaptable moulding machine, and Mr. Shearman explained the construction and operation, pointing out that their standard machine

provided for accommodating pattern plates varying in width from 12 in. to 20 in. and the large machine 18 in. to 26 in. in width. The machines will take pattern plates up to 3 ft. in length.

He then showed a series of slides with the machines in various stages of adaptability and fitted with various types of pattern plates together with the moulds and castings produced from them, the latter being in various metals, and ranging in weight from 1 lb. to 1 cwt.

The Adaptable Moulding Machine Company's products are true to the styling of the Company, as not only do the machines adapt themselves to the various widths of pattern plates, but they can also be fitted with various attachments to meet the requirements of withdrawing pattern plates in various ways. Attachments, such as the turnover attachment and the double lift, together with stooling devices and stripping plates, can be readily applied to these machines to ensure accurate pattern drawing. The Company's latest designs of the "Duplex Series" are very appropriate to foundry use, the first of these machines shown being the two Standard Adaptable machines mounted on one base-plate with a central star wheel for effecting the draw of the two machines simultaneously. This is to meet the requirements of pattern plates varying from 6 ft. to 8 ft. in length and the width of which come within the range of the machines. These machines can be converted back to separate units if desired in a few minutes.

The Duplex rollover consists of two machines mounted on one pedestal. These machines will accommodate varying sizes of pattern plates or core boxes and the load can be arranged to be in balance to the central axis to enable the tackle to be easily rolled over after ramming up ready for the drawing movement which is 12 in. Brackets can be applied for the handling of double-sided pattern plates so as to give a 6-in. draft on either side.

Another slide illustrated a Duplex sand sifter for the treatment of sand in conjunction with the machines. The design can be adapted for electric, hand or belt drive, and standard foundry riddles are used which oscillate in the carrier hoops.

Slides showing three different types of core machines were then shown. These were appreciated by members as it is obvious that the quick production of cores is just as important as the making of moulds.

By way of general interest slides showing the firm's extensive exhibit at the International Foundry Exhibition held in Birmingham in June last were then shown, and were of interest to those who did not have the good fortune to visit the Exhibition.

In conclusion, slides of historic interest showing the turbine casing castings of the R.M.S. *Lusitania* in the foundry floor and also ready for shipment to the machine shop were shown. These castings varied in weight from 30 to 40 tons, which is well out of the range of moulding machine practice, and which substantiated Mr. Shearman's remarks to the effect that "the highly skilled moulder will still be in demand in spite of moulding machines."

American Machines.

MR. W. RAWLINSON stated he had chosen slides representing machines applicable to the class of work in which Sheffield foundry managers and foremen were interested. These slides covered a wide range of machines, including those for small and large work.

In the former class came the modern press machine, with a turnover table consisting of an open frame to accommodate various sizes of boxes and, as often was the case, both top and bottom parts at the same time. The machine both pressed the sand in the box and effected the withdrawal of the box in a downward vertical manner. An ingenious and simple method of clamping the boxes to the turnover table, the clamps being instantly released when the pressure was put on, was a distinctive feature. The machine could be employed with either hand or pneumatic power. Slides were then shown and the operation explained of the well-known Osborn jolt press machine, and the Mumford type split-pattern machines. Both types of machines were particularly adapted for small repetition work. These machines covered requirements for using single or double-sided pattern plates and odd sides.

Under the heading of power machines for large work, slides were shown and detailed explanations given of the design, construction and operation of both the Mumford and Osborn types of jolt-ram moulding machines.

The Mumford type jolter is in very large use, chiefly because of its simplicity in design, its low power consumption and the unique fact that boxes, patterns, etc., need not be clamped to the table, but remain in intimate contact with the table during jolting. This is of particular value for jobbing work.

The machine consists simply of a plain table carried by a plain piston operating in a vertical cylinder. The impact takes place all over its under surface, so that uniformity of ramming is secured and reasonable overhang of boxes over the table is common practice. One valve serves to operate the machine. The machine can be fitted with box-stripping arrangement operated through two pneumatic cylinders which raise and lower the yoke carrying four lifting pins. The movement of the two pistons is synchronised by means of connecting links and of a back horizontal shaft on the baseplate frame. This arrangement ensures a dead true draw, and it is common practice to effect box stripping without the use of stripping plates.

In the case of the Osborn direct-drawn roll-over jolters the moulding operations are further simplified in that the moulding box, when rammed, is rolled over on the table by power and the pattern drawn upwards vertically from the mould. The whole of the operations are controlled by two valves, one for jolting and the other for rolling over the table and drawing the pattern. A levelling device is provided on the truck or carriage which receives the rammed mould. This levelling device ensures that the joint of the mould is always square with the direction of draw. In addition to slides being shown of the various machines, a large number of slides were shown illustrating the actual operation of the machines in foundries.

THE PRESIDENT said they were very much indebted to the four gentlemen who had spoken for the trouble they had taken in preparing this matter and for the admirable and concise way they had dealt with it. They had relieved him of very considerable anxiety in confining their remarks to their own particular subject. They had put before them some very interesting information, which would be of direct value to them.

DISCUSSION.

Universality of Machines not yet Achieved.

MR. JOHN R. HYDE said no doubt members had been impressed with all the four types of machines, but they had to bear in mind the particular job they were going to use them for. They all knew the hard and laborious work there was in a foundry, and particularly the handling of the sand. This always appealed to him when visiting a foundry where they made large castings 40 or 50 tons in weight. Every moulder would welcome some mechanical device which would do away with the tedious process of ramming. They had regularity from the machines, which was an advantage in studying quality at the same time as economy. With the machines they had uniformity, which was a big advantage in the machine shop. There would never be produced a universal moulding machine capable of doing every job that came into Sheffield.

MR. SHARPE said he agreed that the most important thing for anyone considering the installation of moulding machines was to find out which type suited his purpose. It would be a very difficult matter if anyone of the four of them were to dictate on that point! This was the first public lecture on the sand-throwing machine in this country. They were being used in Britain, America, Belgium, Switzerland and India, and were producing good results. They were attacking quite a different phase of work from that of the average moulding machine. The operation now became purely one of transport. There was no question about the ramming, and it was done so quickly. The principle was

totally unknown to 999 out of ever 1,000 foundrymen in this country.

Colliery Tub Wheels.

MR. STEELE, in reply to a question put by Mr. Offiler, said that "Ajax" machines were making colliery tub wheels. On their machines they could make such a mould in 30 seconds, and the top part in 20 seconds. In fact, he asked everyone who was standing round at the Foundry Trades Exhibition to take the time for themselves. Being a mouider, he knew it was almost impossible for anyone installing the machine to expect their moulders to do what a demonstrator could do. If it took him a minute to make a complete mould, then surely two boys should be able to produce a mould in three times his time. Mr. Steele proceeded to give details of work done.

MR. SHEARMAN said, with reference to the tub wheels, some castings could be made on the Adaptable moulding machine. This was essentially a hand-ramming machine. Two boys with two adaptable machines could put down a complete mould every five minutes. No definite law could be laid down until they knew what kind of work was required. As far as a plain flat back job was concerned, they could put it on the machine and it required no registration, but for an irregular joint it is necessary to have definite registration. The Adaptable machine could be used on any similar job.

MR. RAWLINSON, dealing first with the question raised by Mr. Hyde regarding sand preparing, stated that the handling and preparing of moulding sand was of vital importance if moulding machines were to be fully utilised.

On the Continent this factor had been recognised, with the result that, apart from the improved finish of castings produced as a direct result of the provision of proper sand, the moulding machines could be worked to the fullest extent, sand being readily and continuously available, and, as a consequence, maximum output from the machines was secured.

It could be said quite truly that in this country all moulding machines were limited in their effective capacity by the lack of proper sand-preparing and transportation equipment—hence the great importance of this department of foundry equipment.

Several gentlemen raised the point as to the choice of machines for the various requirements. Mr. Rawlinson pointed out that with the infinite range of castings produced it was obviously impossible to lay down definite laws and rules. Broadly, the work could be divided into two main divisions—(1) small work; (2) large work.

Taking the first class, where only small quantities were required from unit patterns, simple hand machines would be best—machines that either effected the withdrawal of the box or pattern, or pressed the sand in the box and drew the pattern or box.

In the case of large quantities from unit patterns, power machines effecting both the pressing of the sand and the separation of the rammed mould and pattern, became a sound proposition.

In this connection, press machines fitted with jolt ram cylinder offered an efficient means of securing uniformly-rammed moulds, a vital necessity if the castings were to come out having uniform thickness.

Division (2) includes the case where castings are required in small quantities. The best proposition is a plain jolter, and the best machine is the one of simplest design, and the one offering the greatest facility in changing from one job to another.

For repetition castings of larger size, the type of machine most suitable is the one that will handle the box by rolling over the table, and subsequently withdrawing the pattern.

MR. FEASEY (Lincoln) said that if a machine cost £1,000 or more and was not definitely suitable for small work, he would not care to ask his directors to grant such a sum. Ramming was the most important thing for consideration, as it meant the hardest manual labour. The Beardsley-Piper machine did its work splendidly, and included all the necessary sand-handling. For ordinary jobbing work of a medium size he did not think they could do better at the moment than follow the jar ramming roll-over machine.

MR. RHYDDERCH observed that it was stated that the skilled moulder was disappearing. They had heard a good deal said about different machines, but nothing was said about the electric type. With reference to colliery wheels, superficially it appeared very advantageous to turn out so many wheels per hour, but one factor had been omitted, and that was the carrying of the boxes to and fro. They could not dump the boxes all round the machines; it was necessary to set them out after some definite method. At the present time they simply tipped the box over and back again.

The Authors' Replies.

THE PRESIDENT expressed their thanks to the gentlemen for the interesting facts they had placed before them.

MR. SHARPE, in reply, remarked that they were developing a machine which would run along the tram rails and be quite free.

MR. STEELE referred to the making of colliery tub wheels, and MR. SHEARMAN observed that there was no machine put on the market that would do away with all moulders or do everything. The time would never come when the highly skilled moulder was not wanted. The idea was being circulated that machines were cutting out the workmen, but he could not say that. The moulding machine to-day was in its infancy, and it was going to stay, but it would never cut out the highly skilled moulder.

MR. RAWLINSON also replied, and the proceedings concluded.

Book Review.

DROP FORGING AND DROP STAMPING, by Henry Hayes. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 2s. 6d. net.

For foundrymen drop forgings have great interest as a competitor against their products. If a buyer says that he can purchase a certain article so much cheaper and stronger as a drop forging, the average foundryman is lost for an argument. In other words, the drop forging is a competitor of which the potentialities are an unknown quantity for him. Perhaps the manufacturer of drop forgings on his side has to meet the same proposition, for Mr. Hayes, dealing with steel castings, states: "Electric steel castings now compete with drop forgings in some applications, the number and scope of which is likely to extend. Many engineers have vivid memories of the days when steel castings resembled archæological curiosities." It is obvious that foundrymen should have a working knowledge of the process, and this little book contains all that is necessary except, perhaps, some details of the cost of the process. The work must be of a repetition character in order to warrant the cost of the die or dies. The book would be infinitely more interesting not only for foundrymen, but for engineers also, if contemporaneous costs could be given for a large quantity of a nickel-chrome heat-treated steel casting and of a plain carbon steel drop forging. We were interested to learn that such relatively mild material as a 0.6 per cent. open-hearth steel in the unhardened condition can be used for dies. We should have thought that about 0.85 per cent. crucible material, hardened and tempered, would have given better service. There are several other little points we might discuss, but they could not detract from the general usefulness of the book.

Aciéries de Micheville.—This French concern reports for the financial year ended June 30, 1922, profits amounting to 1,757,529 fcs. (say, £27,460). A dividend of 5 per cent. is to be paid on the paid-up capital and, after sundry appropriations, the sum of 1,423,156 fcs. is to be carried forward.

Hauts-Fourneaux et Fonderies de Pont-á-Mousson.—The recent general meeting of this French concern passed a resolution fixing the dividend at 30 fcs (15 per cent.) gross per share fully paid up before the beginning of the financial year. The output of the works at Auboué, Pont-á-Mousson and Foug last September was in the aggregate 55.22 per cent. of the pre-war output, as compared with 40.23 in September, 1921.

Apprenticeship and the Foundry Trades.*

By T. Makemson, Assoc. M.C.T. M.I.Brit.F.

Introduction.

The question of apprentice training has received much attention in the Institution of British Foundrymen. It has formed the subject of, or has been referred to in numerous Presidential Addresses, and quite a number of able papers have been given on the subject before various Branches of the Institution. The author does not think it necessary to apologise for once again re-opening the discussion, because in spite of all the attention which the subject has received we are still a long way from having found a satisfactory solution, at any rate so far as foundry apprentices are concerned.

In the Middle Ages, industry was largely a local affair, and every district was practically self supporting. Apprenticeship was a very highly organised matter. The trades were mostly of a domestic character, such as those of the carpenter, the smith and the glover, and the Guild which regulated the conduct of the trade in a particular district also regulated very closely the admission and training of apprentices. In those days there were, of course, no engineering trades; there was, however, some founding, the castings made being cannon and domestic articles. The Guild system passed away centuries ago, but trades of all kinds continued to be taught by close contact of master and apprentice, and the seven years legal indenture together with the arrangement whereby the apprentice lived with his master, continued down to quite recent times. With the introduction of the steam-engine and the growth of the factory system, many new trades came into being. The personal contact between the apprentice and his employer gradually resolved itself into contact between apprentice and foreman, or between apprentice and workman. Even to-day this system of learning a trade exists extensively in theory if not in practice, and an apprentice is supposed to learn his trade by constant association with the workmen in the workshop.

In trades which are largely in the hands of small employers this probably works out very well, but the position is different in the engineering industry. Engineering works and foundries are tending to become very highly specialised; not only do individual works confine themselves to a restricted class of product, but specialisation inside the works also is growing rapidly, and repetition work is the order of the day. Production is being speeded up; systems of payment by results are being introduced, and we are forced to alter our methods of organisation and management whether we like it or not. All these changed conditions make it difficult for the foreman or workman, however well intentioned he may be, to give an apprentice the necessary attention that will ensure his becoming a good all-round workman.

In the foundry trades specialisation and modern systems of management have not perhaps come into existence quite so rapidly as in the machine shop, but conditions in the foundry are rapidly approaching the same state, and are making it just as difficult for the modern foundryman to give adequate attention to his apprentices. Furthermore, we in the foundry are confronted with another difficulty: that of inducing suitable boys to enter the trade at all. These considerations make it imperative that the whole question of apprenticeship should be faced and reviewed in the light of existing conditions. It is a shortsighted and mistaken idea to think that this work can be undertaken by someone else: it is a matter for every employer to take up himself. The efficiency of the next generation of workmen depends upon the attention which the individual employer gives to the training of the present generation of apprentices. Many firms have already faced the problem and have put into operation systematic schemes of apprentice training which are designed to take the place of the old-time method of personal contact which is now rapidly dying out of existence. It is the intention in this paper to discuss some of the factors that should be considered in framing a systematic scheme of apprenticeship for the engineering trades in general, but more particularly for the trades connected with the foundry industry.

Selection of Apprentices.

The first consideration in any scheme must be that of admission of candidates; the selection of the type of boy whom experience indicates is most likely to be successful in that particular trade. Too many people appear to be square pegs in round holes, and so are doomed to failure, or at best to mediocrity from the very outset. It is admittedly difficult to determine positively for which trade a boy is best fitted, but everyone knows of really glaring cases where the exercise of a little common sense and forethought would have prevented a boy from drifting into a job for which he is obviously unfitted. In the foundry trades unfortunately there is frequently an insufficient supply of candidates from which to select, and so one often has to take whatever comes along. There is no dearth of applicants for fitting and patternmaking, but in the case of the foundry, the supply of good material is generally below the demand. This state of affairs is undoubtedly due very largely to the fact that foundry working conditions appear to be so unsatisfactory. Foundries in the past have been dilapidated and insanitary, the work has been performed under the worst conditions, and in many places these conditions still exist, and so the trade has acquired an undesirable reputation. When a boy enters a foundry, even of the best type, he or his parents soon learn of this reputation, and the undoubtedly rough time that a novice experiences, together with the dirt inseparable from even the best class of foundries, very soon seems to confirm their fears, and the boy leaves the trade before he is able to see what it is really like. If the conditions are examined and compared with those prevailing in other trades, this evil reputation does not appear to be justified. Moulding is a dirty and dusty occupation, but the dirt is removable, and that is more than can be said for the dirt and grease which the average millwright and erector accumulates in the course of his work. The conditions under which the millwright work are frequently worse than those of the foundry worker. There are few operations so unpleasant as crawling about dirty, oily gearing, yet an apprentice who shuns the one trade submits quite cheerfully to the other.

Bright Prospects Anticipated.

The boy from the Central School and the Secondary School will not shun the foundry trades if he is approached aright. It is necessary that we should explain to him quite honestly and candidly what foundry life really does mean. In the past the unpleasant features of the trade have been stressed a good deal. Let us still tell the boy about this side of founding: it would be a mistaken policy and a wrong policy to do otherwise, but let us point out some of its advantages also. There are no trades that are more interesting, that call for greater skill and more intelligence than the foundry trades, and there are no trades that offer better prospects of a comfortable livelihood. Furthermore, there are excellent prospects of advancement. The foundry apprentice or workman who gives some attention to the underlying principles of founding and who has had a fair general education has a much better chance of rising to a position of responsibility than a corresponding type of man in other trades, as he is in more of a virgin field. We in the trade realise these things, but in the past we have kept them to ourselves, we have grumbled about the dirt and the hard work, and we have said little about the interest and the rewards. If systematic efforts are made to interest school boys in foundry work and to show them what it really is, boys of the right type will come forward in greater numbers.

* A Paper read before the Burnley Section of the Lancashire Branch of the Institute of British Foundrymen.

Admission Requirements.

Age.—The usual age of admission is between 14 and 16 years. The former limit is governed by the minimum school-leaving age, the latter by the necessity for serving an apprenticeship of at least five years before the age of 21 is reached. It is undoubtedly to a boy's advantage to stay at school until he is 16 if possible. He is more observant and learns more rapidly than if his school career had been cut short earlier; he does not therefore suffer any disadvantage from serving a shorter apprenticeship. The majority of boys enter industry before they attain the age of 15. Many parents are unable to keep their sons at school longer, and many employers adopt the somewhat shortsighted policy of declining to take a lad as an apprentice after he has reached his 15th birthday.

Standard of Education.—It is often urged that because there are many excellent foundrymen whose education is somewhat meagre, an educational test is no indication of a boy's capacity to become a good workman. This is only partly true. In the past many men have been successful, not because of their lack of education, but in spite of it. Given the opportunities, such men would have taken full advantage of them, and would probably have been even more successful. The youth of to-day has the opportunity; lack of the rudiments of education in the case of the present-day boy is therefore usually an indication that he has failed to take advantage of his opportunities, or that he does not possess the capacity to take full advantage of them. Quite apart from this, it is desirable to attempt to raise the educational level of the man in the foundry. The moulder of the future will be a man who takes an intelligent interest in his work. He will not be content to perform operations because they are customary, he will want to know why they are performed. The educated workman has a broader outlook upon his work in relation to industry in general, and he is better able to accommodate himself to changing conditions.

Physique.—A boy need not necessarily be big, but he should be fairly robust to stand the strain of foundry life. It is desirable that he should undergo a medical examination of a more detailed character than the usual perfunctory interview with the Factory Act doctor. Such an examination enables the doctor to recommend remedial measures for physical defects, such as bad teeth, defective sight, etc. The examination may take place before the boy starts work or within a few days afterwards.

The methods which have been outlined should indicate whether a boy is suitable for apprenticeship, or not, but they do little to indicate which particular trade he is most likely successfully to follow: there is little to show whether he is most likely to be a good moulder or a good fitter. This is largely a question of a boy's own interest; other things being equal, he will be most successful at the trade in which he is most interested. If a lad is qualified physically and educationally, and if his interests in foundry work has been aroused by the means outlined earlier in the paper or in some other manner, then he is fairly sure of making good in the foundry.

The system of training should be two-fold, viz :—(a) Practical training in the foundry: (b) school instruction in underlying principles or in technical subjects.

Practical Training.

The method of training in vogue in perhaps the majority of foundries is on the lines that a boy on entering the foundry is put on the core bench and acts as a general assistant to the coremakers until another boy comes along, then he is moved on to the moulding floor, and is put as a helper or is given simple work to do by himself. The foreman may tell someone to keep an eye on the lad; more commonly he is left to get along by himself, in which case he gets his knowledge by inquiring from the men in the neighbourhood. Men have not got the same opportunity of looking after boys at the present day that they formerly had, the boy is therefore not *taught* his trade at all, he *picks it up*. The boy of strong character and exceptional ability will probably learn better in this way than if he were carefully taught, but the majority of boys do not possess exceptional ability. It is necessary to make plans to suit the requirements of the average lad—the lad of ordinary intelligence, but with no particular push about him, hence the necessity for adopting a systematic method rather than leaving the apprentice to find everything out for himself. The following is a summary of some of the types of training schemes which are in operation.

Current Methods.

In small foundries, the foreman may administer a scheme of training which he has on paper or in his own mind whereby the apprentice moves on from one class of work to another at an appointed time. The foreman sees that the apprentice is definitely put under the care of a competent workman and frequently takes a hand himself, and instructs the apprentice. There is much to be said in favour of a simple arrangement like this, provided that a carefully prepared scheme is really worked and that it does not exist on paper only.

Another method which has met with much success is the provision of special apprentice workshops where the boy spends either a part or the whole of his apprenticeship, and is then transferred to the ordinary foundry or workshop. The apprentice training shop is more than a school; ordinary manufacturing work is performed on a commercial basis, but the shop is manned by apprentices under the control of competent instructors. Most of the shops of this type are engaged in the training of fitters and turners, as the idea has been applied only sparingly to the foundry trades. There are a few such shops in operation in this country and on the Continent; in the United States, however, they are fairly common in some of the larger works.

The drawback to the special apprentice shop is that the apprentice tends to become academic in his ideas. True he learns to do things in a systematic and correct manner, but he often misses the little short cuts and practical dodges of the experienced workman. He is not brought up against the little snags and difficulties of everyday life in the foundry, and when he does get into the foundry he has much to forget.

Apprentice Instructors.

Quite a number of firms are now finding it advisable to appoint men in the foundry and in other departments also, for the sole purpose of supervising the training of their apprentices. The duties of such men may comprise some or all of the following:—

(*a*) Teaching the apprentice his trade and supervising his work.

(*b*) Selection and engagement of apprentices.

(*c*) Teaching in the Works School where such is provided.

(*d*) Supervision of welfare activities amongst apprentices.

Instruction and Supervision.

The duty of the instructor is to show the apprentice how to do his job; definitely to teach him and to explain to him matters which he cannot easily find out for himself, and if necessary to get down and do part of the job for him. He moves about from one apprentice to another; with one boy he may only need to spend a few minutes, with another he may have to stay two or three hours. He is in constant touch with his boys; if a lad is doing his work in the best possible way the instructor leaves him alone; if the boy's method can be improved then the instructor shows him how to improve it. In some works where it is not possible to provide sufficient instructors to give every apprentice detailed assistance, the instructor may have the oversight of apprentices in several departments. In such cases his methods may be modified somewhat; he still however retains close contact with each boy and sees that the boy is obtaining the best experience that the particular foundry affords. It is the instructor's duty to follow the progress of the apprentice and see that he is not overlooked.

Instruction Supplementary to Shop Training.

For some years there has existed a feeling that the evening continuation schools, admirable as they are, do not altogether meet the requirements

of the embryo workman. During the earlier years, the work in these schools is largely a revision and a continuation of the work of the elementary schools.

This is, of course, very admirable and very useful, but as the student advances the instruction he receives tends to become less practical and more technical in character. The evening schools have done, and are still doing, very useful work, and with their assistance many men have risen to positions of responsibility; these men, however, are only a few out of the great number of students who have attended. The trouble is that much of the work in the evening classes is too technical, or to use a much-abused word, too "theoretical" in character. The studies of the early stages are largely preparatory to more advanced work, but the majority of students leave before they arrive at the advanced work. The work they have done is useful as a mental training, but it has little practical application because it is intended to be a preparation for something else. It would be much better if the energies of the students had been directed to something less ambitious but more immediately useful.

Trade knowledge as a rule is catered for only very scantily, and here the foundry trade is served very badly. It is possible in all industrial districts to learn machine drawing and shop calculations, but other subjects that are of immediate use to the neophyte foundrymen are only taught in a few places. Mention should be made of the classes in foundry subjects which have been organised at Manchester, Burnley and a few other centres. Excellent work in this direction is done at the Foundry Technical Institute at Falkirk.

The lack of support that has been given to some of the existing foundry classes is undoubtedly due to the fact that a boy is frequently too tired, both mentally and physically, to apply himself to close study after his day's work is over. The average lad requires relaxation, and as a rule he sees that he gets it. It was the recognition of this difficulty that led to the passing of the 1918 Education Act which provided for compulsory attendance at Continuation Schools in the day time. The operation of this Act was postponed owing to the necessity for national economy. Attendance at Day Continuation Schools is already compulsory in some countries. In this country and in U.S.A. many employers have recognised the necessity for such education, and have established schools on their own premises. These schools are conducted during working hours at the employer's expense.

Works Schools.

These may be divided broadly into two types:—(1) Those whose curriculum is similar in character to that of the ordinary Evening Continuation School. (2) Those which aim principally at supplementing the training given in the workshop.

Works schools of the first type suffer in that they are trying to do what is already being done by the Local Education Authority in the Evening Schools. There is the advantage of the work being done in the day time when the student is fresh, but the nature of the instruction is similar to that to which reference has already been made.

In works schools of the second type trade instruction is given; the phrase "trade instruction" being used in its broadest sense. It is this type of work that is the true function of the works school. The workman of to-day and of to-morrow will be something more than a manual worker, he will have to work with his head also. We are beginning to realise that advancement in foundry work requires an understanding of the scientific principles underlying the trade, not only on the part of foremen and managers, but also by the workmen. A good deal of this knowledge can be imparted collectively to a class of boys in a schoolroom. There is no suggestion of supplanting practical work in the foundry. The foundry is the place in which to learn to be a moulder, but the school instruction is a most useful supplement to the practical work. The two together, instruction in the shop and instruction in the school, make a complete system of apprenticeship.

Trade Instruction in Works Schools.

The following suggests the kind of instruction that may be usefully given in a works school:—

Moulders and Core-makers.

1. Revision of elementary school work in arithmetic and general science.

2. Elementary machine drawing and sketching. It is of much more importance that a foundryman should be able to make good sketches than is generally imagined. The fact that many excellent craftsmen do not possess this accomplishment is no reason why it should not be possessed by the next generation of foundrymen.

3. Detailed lectures on the underlying principles of foundry practice, *i.e.*, runners, risers, venting; properties of sands and the many other practical details which have a scientific foundation which is too frequently misunderstood.

4. Consideration of the methods of making the various castings usually made in the foundry with which the school is connected. Some attention should also be devoted to other types of work in order to widen the outlook of the boys.

5. *Foundry Metallurgy.*—This should include some account of the manufacture of pig-iron, the influence of the constituents of iron upon its properties and a detailed study of cupola design and cupola practice.

Pattern-Makers.

(1) Revision of elementary school work in arithmetic and physics. (2) Drawing and sketching. (3) Pattern-making materials; contraction; use of prints; loose pieces, drawbacks, etc.; methods of pattern construction. (4) Complete instruction in methods of constructing and laying out patterns and core-boxes for representative jobs. Making boards for loam moulding and patterns for plate moulding.

In all this work attention must be given to foundry requirements, and in considering any job the method of moulding the job should always be discussed. It is desirable to devote a few lessons to the purely metallurgical side of the foundry in order to widen the outlook of the apprentice.

Welfare Work.

When discussing the work of apprentice instructors a suggestion was made that they might combine welfare work with their other duties; although the possibility is suggested, it is not recommended. The instructor's duties should be concerned with matters of training and administration, at the same time his position among the boys does give him excellent opportunities of assisting and advising them on other matters in an informal manner. It is found that assistance given by the instructor in this way is appreciated, and his advice is followed more closely than if it came from a specially appointed welfare worker.

Promotion.

A systematic training scheme enables an employer to find those of his apprentices who possess outstanding ability and who are capable of filling positions of responsibility. It is a sound policy to train such boys to undertake more responsible work, and a scheme of training such as is outlined here, while being an end in itself, is also sufficiently broad to become a foundation for more advanced work. An appreciable number of vacancies in supervisory positions and in technical departments such as the drawing office should be filled by promoting the more able trade apprentices. Among the advantages of such a system are:—

(1) It is fair that ability and hard work should be rewarded.

(2) The employer benefits by making a fuller use of the capabilities of his employees.

(3) The opportunity of promotion acts as an incentive to the general body of apprentices to improve themselves.

(To be continued.)

The Institute of Metals.

The Annual General Meeting will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1., on Wednesday and Thursday, March 7 and 8, and the Annual Dinner at the Trocadero Restaurant on March 7. Members may invite guests.

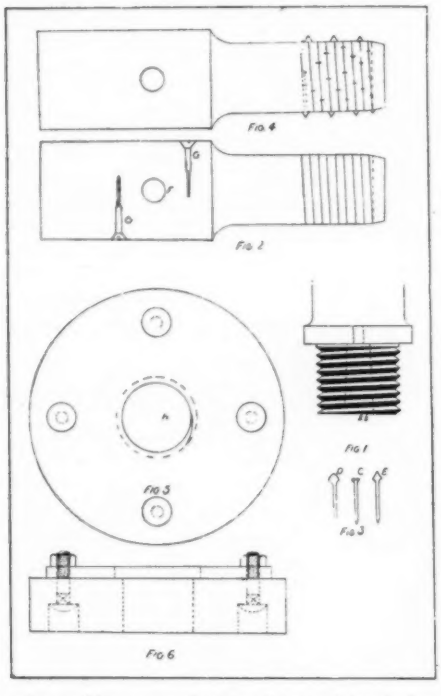
Wood Face-Plates for Pattern-Shop Lathes.

BY V. DEWHURST.

Very few pattern shops can boast of a superfluity of face-plates for their lathes. After thirty years, spread over working and visiting a large number of pattern shops and foundries, it is astounding to still find that the attitude adopted that "anything will serve for a pattern-shop lathe, if it will only go round." Its attachments are likewise deplorable.

From the above can be ascribed the difficulty of getting face-plates duplicated in these shops. Generally each pattern-maker turns up and finishes his own work in the lathe; and it often happens that he has to wait until some man has finished with the necessary face-plate. If the practice be that a special man is kept for lathe work time is still lost by the bench hand, if the one face-plate is in use, but with an equipment of several plates time is undoubtedly saved and annoyances avoided.

These difficulties were eliminated in the writer's



shop by making several sizes of face-plates in hardwood by the following method:—In Fig. 1 the screwed-end of lathe spindle is shown. It is $2\frac{3}{8}$ in. dia. over points, and has four threads per in. At the bottom of the thread is $2\frac{1}{8}$ in dia., whilst the complete screw is 2 in. long.

Two pieces of suitable hardwood, say 8 in. sq. and $1\frac{1}{2}$ in. thick, are securely glued and screwed, with the grain crossed and provided with a hole in the centre equal to the diameter at the bottom of the thread ($2\frac{1}{8}$ in. dia.). A piece of soft pine, 12 in. long by 3 in. sq., is turned to $2\frac{1}{8}$ in. dia. along half its length, as shown in Fig. 2. By forcing this through an iron face-plate by a turning movement, as if tapping a thread in a nut, a faint indication of the thread in the plate will be formed on it. Or, the pitch of the thread, being four per inch, a piece of paper tape $\frac{1}{4}$ in. wide and about 36 in. long, wound round this peg (which will be the tap) in a spiral form, will give the required lines of thread. For this purpose about thirty oval wire sprigs $1\frac{1}{2}$ in. long, as shown at C, Fig. 3, are hammered out flat until they appear as D, Fig. 3. Afterwards they are ground or filed to thread shape as at E, Fig. 3. They are then driven into the spiral lines of thread at intervals of about 1 in. This is accomplished by using a pricker in the wooden peg (tap) to make holes for the reception of these nail cutters. A light hammer must obviously be used. A little dressing with small file will soon set right any irregularity. The job will now appear as shown in Fig. 4. After drilling a hole for a tommy-bar at F, Fig. 2, and inserting a few wood screws as at G, Fig. 2, to prevent splitting, the tap is complete.

The tap is then inserted into the prepared hole of the wood plate shown at H, Fig. 5, carrying out the operation as if tapping a nut in the usual way. A little extra care, however, must be used to ensure a good thread.

After removing the tap whilst the plate is in its square form it is advisable to force it on and off the screwed end of the lathe spindle a few times, and then to cut to a circular shape. After this it is refixed on the spindle and trued up. These threads will stand good for years, providing a little plumbago is used occasionally.

An improvement can be made by using one piece of wood, 3 in. thick, backed with an iron ring-plate fastened as shown in Fig. 6. The writer has had several of these plates in use over ten years, and they are still in service.

American Pig-Iron Output, 1922.

Pig-iron production in the United States during December totalled 3,086,898 tons, and was the largest output since October, 1920. The average daily output of 99,577 tons was an increase of 4,587 tons over the November average. Figures of pig-iron output for the whole year compared with 1921 and 1920, as given by "The Iron Age," are as follows, in gross tons:—

	1922.	1921.	1920.
January ..	1,644,951	2,416.292	3,015,181
February ..	1,629,991	1,937,257	2,978,879
March ..	2,035,920	1,595,522	3,375,907
April ..	2,072,114	1,193,041	2,739,797
May ..	2,306,679	1,221,221	2,985,682
June ..	2,361,028	1,064,833	3,043,540
July ..	2,405,365	864,555	3,067,043
August ..	1,816,170	954,193	3,147,402
September ..	2,033,720	985,529	3,129,323
October ..	2,637,844	1,246,676	3,292,597
November ..	2,849,703	1,415,481	2,934,908
December ..	3,086,898	1,649,086	2,703,855
Total ..	26,880,383	16,543,686	36,414,114

The record year in pig-iron production was 1916, when 39,039,000 tons were produced.

A New Two-stage Process for Producing Basic Steel.—Owing to the various disadvantages inherent to the ordinary two-stage process, M. Riat has adopted the process described below, for which he claims:—(1) Reduced loss from eruptions. (2) Considerable increase in output due to heavier tappings and quick decarbonisation at high temperature during the second stage. M. Riat estimates that the increase in output may amount to 25 per cent. (3) Owing to the short duration of the second dephosphorising stage the resulting steel is less oxidised, requiring smaller additions of ferro-manganese and decreasing the amount of iron in the slag whilst increasing its P_2O_5 content. Slags have been obtained containing less than 5 per cent. iron. In a first series of experiments three or four tons of liquid steel were left in the converter; sufficient limestone was added for the subsequent operation, and the whole mass was blown for two or three minutes. Molten iron was then added and blowing could be effected without loss from eruptions. Owing to the wear and tear on linings and the inefficient use of the converter capacity this method was abandoned. The method subsequently adopted was, briefly, as follows:—In the first stage the charge consists of the whole of the limestone and scrap, to which from 30 per cent. to 75 per cent. of the iron is added. This portion is now blown until the slag is of the desired composition and fluidity. Since the charge is light and contains much lime, there is no loss from eruptions, and the phosphorus is rapidly removed owing to the low temperature and the excess of lime. In the second stage the remainder of the iron is added and the blowing is finished in the usual way. The process, which is particularly suitable for dealing with hot metal, has two disadvantages—the great wear on linings, which seems greater than in the usual method, and in certain cases the rapid choking up of the spout and sides of the converter at the surface level of the bath, due no doubt to the temporary hardening of the slag at the beginning of the second stage.

A Brief Survey of the Foundry Industry.*

By Frank Hill, A.M.I.,Brit.F.

In his Presidential Address, Mr. Roberts referred to the question of new entrants to the industry, asserting that we are not obtaining the best class of boy. The object of this Paper is that, by surveying the past, to find some reason for the present backward position instead of the prominent place the foundry should occupy. From a trade point of view, it is a regrettable fact that this tendency of drift should continue. A youth seems to drift into the industry, not with the idea of learning, but rather with the intention of earning a wage until something better shall come along. Thus the industry is depleted of its potentialities; and when the tide has receded, we very often find left behind only ignorance, and this where intelligence is most required to deal with matters that entail a high degree of thought, and where an ability to tackle some of the most obstinate of questions that are awaiting solution to-day is imperative. It is possible for the individual to be doing more than is being done to-day. If each were willing to bear his part of the burden, a marked change would become apparent. We all recognise that the hard physical labour of the foundry does not tend to produce a very clear mentality, for the strenuous exertions necessary to perform foundry work seem to lower the perceptive powers. That there is very often little desire left to study research or to give consideration to suggestions made by prominent members of Associations such as this, is only too true. The result is that theories are not put into operation because of incompetence on the part of the practical men.

Theory and Practice.

It was a theory in the mind of Benjamin Huntsman, about the middle of the eighteenth century, that a better steel could be produced than that imported from abroad at that time; but only by the practical application of his own theories did he ultimately succeed and give to the world the secret of making cast steel. It was with such thoughts as these in mind that the author set out to write his Paper, but he soon discovered that neither Huntsman nor Dud Dudley, while both doing pioneer work, could be regarded as the real pioneers of the foundry industry. It was necessary to cast one's mind back many centuries previous to obtain even the briefest outline of foundry work. Proceeding, Mr. Hill said he had only been able to deal in the abstract with the subject. As the ancient and modern are so closely interwoven, it is easy to see that the modern is only the ancient in another garb; the connecting link being man's desire to put metal to a better use than hitherto. The industry is therefore probably co-existent with the human race, for there can be very little doubt that iron was put to a practical use at a very early period in the world's history. So early, in fact, that, with the exception of agriculture, metallurgy can be described as the premier industry of the world, and as having a direct bearing on the history of the human race. Every period of the ascent of man bore proof of an insight at least into metallurgy. So remote is the inceptive idea of the industry that Professor Petrie tells of his discovery of iron ornaments in Egyptian mummy cases dating back 3,000 years B.C., showing clearly that at that early date a degree of proficiency had been acquired which we moderns rarely suspect. They also had an account of the building of Solomon's Temple, and the details of the making of highly ornamental brass columns; the dimensions being given show that their weight must have been from 30 to 35 tons each—an amount of metal that even to-day required the skill of competent men to handle. If we substitute the word "loam" for "clay," we find that instead of loam moulding being first practised, as stated by Mons. Varlet at the Foundry Congress in Birmingham last June, in quite recent times, it is one of the oldest phases of the industry. According to Dr. Longmuir, prehistoric man living in the bronze age was undoubtedly a loam moulder; while the making of Solomon's Temple columns proves that engineering generally had reached such a stage that warrants the belief that powerful machinery existed—otherwise such castings could not have been produced. The founders at the opening of the Christian era were in possession of knowledge that would be of inestimable value to-day, for their knowledge of the non-ferrous metals must have been very deep, or they could not have dealt with them as they did. That we should think of putting a cutting edge on a copper chisel seems ridiculous; yet it has been an accomplished fact, for tools made of that metal are known to have been in general use in the time of the Romans. In fact, this accomplishment appears to have been transferred rather than acquired, as Prof. Zimmer, in a Paper read before the Iron and Steel Institute, cites an instance of the discovery of a large meteor showing distinct evidences of chipping, together with the copper chisel used, which had been left behind by the prehistoric workman. However, we can get no authentic account of the furnace or of the means of smelting, but there is good reason to believe that charcoal was the fuel used in these early days. Of course, the blast was something different from the picture of skins being inflated and deflated by the pressure of men's feet, which, to his mind, had about the same bearing on the actualities as a picture of the village blacksmith compared with a modern forge.

British Foundry History.

Coming to more recent times, Mr. Hill said the blast furnace was in existence in Sussex in the fourteenth century. The great forests which then covered the country, including those of Gloucestershire and South Wales, were requisitioned for the supply of the necessary charcoal fuel. Indeed, so much had these forests been denuded that, by the time of Elizabeth, the building and upkeep of the Navy was thereby endangered, oak charcoal being then, as now, the best, so that stringent laws were passed forbidding such wholesale destruction. After much study and experiment, this led up to the adoption of a mineral fuel when, in 1619, Dud Dudley produced both pig and wrought iron, with coal for fuel, in Gloucestershire. But so great was the opposition to the use of the new fuel that eventually it was abandoned, and, so far as England is concerned, very little seems to have been done for another century. Then, in 1735, Abraham Darby, of Coalbrookdale, first used coke as a fuel, and new life and vigour was put into the industry. From this date fresh discoveries followed each other so rapidly as to become almost confusing. Two especially seemed to stand out prominently. These were the reverberatory furnace invented by Cort in 1784, and the use of hot air for the blast furnace put forward by Neilson in 1828, from which dates begin the modern methods of iron manufacture, which has now assumed such gigantic proportions. Hence it is that to-day we appear to have arrived at another crisis. Mechanical methods rather than manual labour have now reached a high stage, with specialisation in every department, while so variable are the uses, so costly some of the products, and so obscure some of the problems connected with the manufacture of metal goods, that it is not surprising so many contradictory reports exist.

Artisans' Lack of Theory.

Practically speaking, an absolutely pure iron is of no commercial value; hence the various constituents which go to make cast iron a marketable commodity, and enter in its constitution either from the fuel or flux, or may be present in the ore. They form a series of compounds consequent on the operation of smelting—minute in many cases, but essential. Yet these essentials are rarely understood by the workman. He often knows that carbon is necessary, that silicon up to a point has a softening effect, and beyond that point an entirely different result; that sulphur

* A Paper read before the Coventry Branch of the Institute of British Foundrymen.

produces hardness, and very often a spongy casting; but when we ask for an explanation, we are at a loss for a reply. Dr. Longmuir recently dealt with some of the difficulties facing us from the practical side of the industry, and there are many foundrymen who could also give valuable help on such matters. In proof of the statement that contradictory opinions exist on all hands, it has been stated that balanced sulphur has no deleterious effect on iron, or that it is almost a negligible quantity and not worth consideration. But such authorities as West, Roberts, Dillner, Howe, Johnson and Dr. Longmuir all agree that sulphur in iron is extremely detrimental, and with these opinions the author agrees. Yet even sulphur can be turned to good account, as in the manufacture of high-class surgical steel; so that what we require is the knowledge of how to harness and control such ingredients, instead of denying their deleterious effects. The day of specialisation has arrived, and the machine is about to dominate the trade, and individual skill seems likely to pass with this domination, with the semi-skilled man taking the place of the skilled. All this change tends to create new difficulties and new problems for future consideration and solution.

Foundry Prospects.

But what is being done to meet these difficulties? What is likely to be the position of the individual in the machine era now dawning? Would he become, as it were, part of the machine—a mere automaton—or will individuality be as necessary as in the past? For, if the machine man became a mere automaton, then a more highly-skilled cupola attendant will become imperative. Or, as an alternative, is the chemist to be given greater responsibility in the control of the foundry? These are some of the questions forcing themselves forward with a persistence that cannot be denied. The position is becoming increasingly difficult, and to attempt to find answers to such questions only seems to add to the difficulties. However, it is contended that the scrap returned from the machine shop will far outweigh any advantage of increased output by these semi-skilled men and their machines, without the supervision of a highly-skilled and expensive staff. Thus, while it may be an advantage to move with the times, and recognising that the machine in the foundry will become an increasing factor, the author has yet hardly been able to grasp the foundry industry being run by semi-skilled labour and machinery, with the almost complete elimination of the thinking machine. It has been said that products from the foundry have reached such a stage, both of intricacy and perfection in results, that warrants the belief that the workers of to-day are the best the world has ever seen, an assertion with which the author cannot agree. The industry has not seen its best; the best still lies ahead. Great questions still await solution, industrial and economic, relating to skill, ability and reasoning power. Indeed, the potentialities of the industry are such as point to its becoming an exact science. They might ask what are the requirements of to-day? Not research just at present. Research has been of great service; it has made great progress possible in the knowledge of foundry materials. The great need of to-day is effort, both individual and collective, and a steady, continuous application of the knowledge already gained. This should enable us to meet some of the difficulties of production, as diversity of opinions must pass before the greater power of knowledge. Youth must be encouraged to use all its faculties, which must always be kept on the alert. A desire to know must be awakened and fostered, interest must be stimulated, the power of observation taught, and ability to reason instilled. These are some of the chief requirements, and, with the application of these powers and faculties, we shall, in the words of Lord Haldane, get "an aristocracy, not of birth, but of talent," in which one man is higher than another solely because his work, his industry and concentrated thought have enabled him to take advantage of the opportunities which his neighbour has neglected.

DISCUSSION.

The President (MR. G. E. ROBERTS) remarked that while they had listened to a comprehensive survey of foundry work from the foundryman's standpoint, he had thought that Mr. Hill might have dealt with the foundry difficulties of to-day as regards the working part of it in rather more detail. He expressed agreement with the view that the semi-skilled workers would not entirely clear out the highly skilled man. His experience had been that however up-to-date they attempted to be in machinery installation, and operated it by semi-skilled labour, they were perforce driven by the work coming to hand to secure highly skilled men to give their attention to it. Therefore he did not apprehend that there was any immediate danger of highly skilled men being left without a job. He believed the conditions were improving everywhere.

Superiority of Machine Moulded Castings.

MR. G. H. JUDD said as machine moulding had come forward during the last ten years, he would like to ask engineering members present whether the machine moulded castings of to-day were as good as those produced ten years back by skilled men.

MR. CRAWFORD (Coventry Engineering Society), speaking of machine moulded castings, said that from the engineering side with the smaller castings they now obtained better results. They found that there was less metal left to machine off, and they could usually rely on the cores being better in position. He believed it was a practice to have patterns for machine moulding produced in the tool room. That possibly accounted in part for better castings being produced by machine than by skilled labour.

MR. S. GLOVER remarked that his main experience until three years ago was in engineering, apart from foundry, work; and it had been his good or bad fortune since to be thrown among many matters in the foundry world in addition to the engineering branch. He now found that most of the troubles he was up against came from the foundry side. The difficulties he used to be faced with in ordinary engineering seemed to be quite minute compared with those that were always cropping up in the foundry. In the engineering business they did have the benefit of all sorts of measuring instruments that facilitated work, but there was a number of elusive things in the foundry which one never appeared to be able to track down. Therefore he suggested that the foundry branch of their industry was probably the most highly skilled.

Tool Room and Pattern Making.

MR. H. ASHMORE considered the men really running the foundries to-day were very highly skilled, more so than in the past. The people who made the patterns and plates for the moulders, made them so fool-proof that they had engineers saying that the castings of to-day were better than they used to be. However, he felt sorry for the man who suggested that the tool maker should make patterns for the foundry. If this was so, then they would get very similar results from the tool maker as they would from the ordinary carpenter.

MR. C. SCAMPTON said he thought that machine moulding was bringing out skilled moulders, because in some classes of foundry work it took a highly skilled moulder to make pattern plates as required, especially in those classes of foundries to be found elsewhere, at which hollowware, grates and articles of that description were made. In this class of work it had been known that 20, 30, or 40 pattern plates had been made before satisfaction was obtained. In such cases as that, very much higher skill was required than for ordinary castings.

The PRESIDENT observed that machine moulding, as compared with loose pattern moulding, enabled them to attain uniformity, and by the latter method they certainly got a heavier casting. They could not get the regularity in a hand rapped job as they did from a pattern machine drawn. Sometimes if the job was moulded one way up, the core was not in the correct position because the taper in the print did not agree with the taper of the core box. He quoted an instance in which the core was one-eighth of an inch out, and said of course their customers blamed the foundry. However, this particular trouble had not occurred

before because the suppliers had moulded the job the other way up so that the fitting was correct.

Destruction of Patterns.

MR. ELGIE (Coventry Engineering Society) said the undue rapping and ill-treatment of patterns, and the damage which was caused in consequence, was appalling. The cost was really terrible, when it was reckoned up from one year to another, and when they considered the "slaughter" of good patterns and the renovating of others. Mr. Roberts had mentioned that the moulder had the privilege of being able to mould castings whichever way he liked, but with this he did not agree. This determination should be decided in the pattern shop, because if the pattern was placed the other way up the taper would be wrong and the bad metal would occur where it should not be. He thought it would be a wise step if an apprentice pattern maker could serve some months or years in a foundry to learn that particular side of trade, which he contended was a most important matter in the economical working of the foundry. At his works they had launched a scheme quite recently in respect to plate moulding, and they had found that they could get far better results by providing the pattern makers with opportunities of going to the tool room. They had educated the pattern-makers up to the engineering standard of using a drill or moulding machine or file, and whatever was necessary to make a real good job. It was not always necessary to make metal pattern plates. They could make a really good job from a hard wood and get the surface quite true if stiffened up with iron strips or something of that sort, that would last not only for a hundred, but for 2,000 or more castings. If a moulder was not careful in handling and ramming, the result would be a bad or faulty casting.

MR. GLOVER said the only satisfactory method of making a pattern in a tool shop was to prepare a drawing of the pattern, not of the part to be made, but of the pattern itself, in exactly the same manner as they would make a drawing of the part to be machined. In other words, a pattern that showed the prints, tapers and everything of that kind which, if a pattern-maker had the job, he would know from experience what to do without such indications.

MR. ELGIE remarked that if they had such state of things they would be obliged to have moulders in the drawing office as well as the pattern shop. But, as a matter of fact, this system was carried out in most pattern shops, with this difference: the foreman pattern maker actually made a drawing with the prints and different things.

Ancient Pattern-Making.

MR. LINNETT, commenting on the skill of the ancient metal workers, recalled the use of bronze tools for cutting through a mile and a half of hard rock, and said they could not produce such tools to-day. Some years ago he saw some brass castings at one of the Institute's conversaziones which dated back centuries before the Christian era. One was a barrel tap, made exactly the same shape, and apparently cored, as they cored them to-day, by the Egyptians.

MR. ASHMORE said he would like to know if Mr. Hill had any knowledge of examples of the pattern maker's art of the early days he spoke of, such as in regard to the making of the brass columns for Solomon's temple. Replying to the President, Mr. Ashmore said what he meant was had there been discovered any records of patterns of those days, or was the pattern maker really the moulder?

MR. LINNETT thought the remark he made answered the question. The particular article he mentioned was taken from Thebes, and was known to date back to 8,000 years. The casting had obviously been cored, as the inside was rough, and had evidently been made from a pattern. It also had a small lip for driving in the barrel. The date was, of course, before Solomon's time.

MR. HILL, replying to the discussion, said he had no knowledge of any pattern records, but he had confined his attention mainly to the moulding side of the industry in his search for material. The point he wished to stress most was that of the drift of young fellows into the trade, not with any idea of learning its technical side, but for the sole purpose of earning a living irrespective of the future. They either wanted to eliminate him or educate him.

Rapping Patterns.

THE PRESIDENT reverted to the rapping of patterns, and said it might be that some foundrymen were rather heavy handed, because they got paid by the weight moulded. But it must be remembered that patterns were often sent to the foundry without having a rapping plate, and if that was the case it could hardly be expected that the foundryman was going to fit rapping plates on such patterns. Therefore the patterns went back to the pattern maker.

British and Belgian Castings.

Arising out of a vote of thanks to Mr. Hill for his address, an engineering visitor raised the question of sectioning up cylinders, and said that his firm, as makers of high-class motor-cars, found that the Belgians turned out the best cylinders and better running engines. Mr. Judd was asked to deal with the matter. Mr. Judd thought it was a moulder's question, as the problem seemed to concern the thickness of the castings. There seemed to be an impression that the Belgians were in front of the British as regards cylinder castings, but to this he could not agree. Apart from his own experience to the contrary, he knew of four big firms who were at present making one type of casting in large numbers for Coventry firms of motor manufacturers, and the Belgians had been ousted. Of course, it was important in sectioning up cylinders of varying thickness to ascertain that there was equal spacing for the successful running of the engine. He was convinced that Belgian cylinders were simply bought for cheapness and not because they were better than British cylinders.

MR. CRAWFORD said Belgian cylinders looked very nice and clean, but when they came to be put into use they found that 50 per cent. had to be scrapped, as they were full of blow-holes.

MR. HILL also agreed that British castings were far preferable.

Birmingham Metallurgical Society.

Dr. Harold Moore, of the Woolwich Research Department, was the lecturer for the January meeting. His paper dealt with some of the less familiar aspects of the Brinell or ball hardness test, which may be regarded as giving a measurement of the resistance of a material to indentation. Owing to the complexity of the stresses and of the deformation they produce, the test does not determine any one fundamental property of the material, but is wholly empirical. Nevertheless, its practical utility is great. Some directions in which its usefulness may be extended were pointed out. The laws expressing the effect of variation in load and in diameter of ball on the hardness number were discussed, and a method of indicating the capacity of a material for hardening by cold work was described. The application of these laws in the employment of small balls and loads for the determination of the hardness of thin specimens was indicated.

The further questions dealt with in the paper included the selection of appropriate loads for various ranges of hardness, the accurate measurement of impressions, the precautions to be precautions to be observed in preparing the specimen, the relative advantages of the ball and the cone for indentation hardness tests, the ratio of hardness-number to tensile strength in steel and in brass, and the use of dynamic methods of applying the ball hardness test.

A small ball hardness testing machine, lent by Messrs. Alfred Herbert, Limited, of Coventry, was demonstrated. The paper was illustrated by lantern slides, and specimens shown.

Companies in New South Wales.—A Reuter's cable from Melbourne states that during 1922 a total of 120 companies were registered in New South Wales, with an aggregate capital of £49,507,000.

A Note on Coremaking.

BY F. J. BEECROFT.

The foundryman is continually searching for the causes of scrap castings, and in recent years he has been materially assisted by scientific investigators. Research work has recently centred on moulding sands, especially in the States, and whilst the subject has only been touched on the surface, much valuable information has been obtained; porosity, refractoriness, and that very peculiar property of bond have been dealt with very extensively, and the knowledge obtained must have satisfactorily cleared up some waster problems.

Such troubles as blowholes, oxides, scabs, rough spots, hot cracks, warps, strains and veins, set the average man thinking about methods of moulding, sand, and metal, but generally, providing it is not an obvious core trouble, he will not look to this last direction for the cause. Every foundryman has had trouble with cores at one time or another, and when the matter has been righted, and he encounters a spell of good luck, he is apt to consider that he will now be for ever immune from faults from cores. It is exceedingly difficult to control coremaking so that results shall be uniformly good, and it is the writer's experience that lack of uniformity in the quality of cores is the cause of numerous wasters which are usually put down to bad metal or faulty moulding. The main requirements of core sand and binders are generally well known, but inconspicuous little details are often not taken to account. Particularly is this so in the production of sea-sand and oil-bonded cores.

These cores have now a wide sphere of utility, and the maker of light, intricate castings, such as for the automobile industry, would wonder how he could get on without them. It is such manufacturers as these having the most difficult castings to make, and the most difficult metals to handle, who find such a big field of subjects to put the blame of their wasters upon, that they are apt to give their cores but scant attention. In most large foundries, casting light intricate work, there is a large core shop, generally presided over by a foreman who has nothing to do with the casting and moulding, and it is only natural that he should uphold virtues of his cores, and attempt to lay the blame of wasters on the foundry foreman.

Defects from Cores.

The writer has found the troubles due to cores such as the following: An automobile differential casing suddenly developed blowholes in a flange on the dome portion. The cores were vented exactly as usual, and were made from the same sands in the same way, but investigation showed that the sands were mixed in a heap some time before use, and that when used in dry weather there was a tendency for the finer sands to slide to the bottom, and the use resulted in a harder and more compact core.

The mixing of core sands should be as perfect as possible, as different grades of sands, if lying in patches, will often cause rough spots, veins, and scabs. Cracks and pulls have been found due to the oil used. The writer used to use linseed oil, but encountered many wasters through pulls. The same oil when mixed with another core oil, reduced the number of wasters through pulls considerably. It is evident that certain blends of oil are better suited than others for certain sands.

Additionally, if the oil is not of the right strength, when the hot metal comes in contact with the core, the binder does not burn off quickly, and the core remains sufficiently long to cause a strain or crack.

Drying Considerations.

The baking of oil sand cores is not as simple a matter as is usually supposed; because the core leaves the oven strong, it must not be assumed that it is all it should be. Not only must the temperature of the oven be uniform, but the admission of air should be regulated as closely as possible. The baking of an oil core is a case of not only drying but chemical action. The air has an oxidising effect on the oil, and if the oil has not had enough oxygen the core will be weak, giving rise to buckles. An insufficient supply of air will leave a much greater volume of gas to be expelled from the core when the mould is cast, causing blowholes. There are products now on the market which are capable of remedying insufficient oxidation in baking, reducing very considerably the amount of gas evolved on casting. Oils can be obtained which will mix with water, so that when the core is baked, there is less organic matter left to be evolved as gas on casting.

In view of the above remarks, the writer has been undertaking a great deal of research during the last few years on binding materials and powders, the former for binding purposes only, and the latter solely for core work alone, and after a lengthy period of practical tests has now put on the market two suitable products for the above use. The success of these products by the various foundries, both in this country and abroad, has more than compensated the writer for the time and trouble in research for the betterment of foundry moulding and core-making efficiency.

Relieving the Steel Scrap Shortage.

We were interested to learn from Messrs. Cox and Danks, Limited, of 168, Regent Street, London, W., that they are establishing a shipbreaking gear at Queenborough. The first two vessels to be broken up are H.M.S. *Orion* and H.M.S. *Erin*. These ships are listed for demolition under the Washington Agreement and will arrive within the next few days at Queenborough, where Messrs. Cox and Danks have taken a lease on the pier, offices, warehouses and adjoining property. The pier is 700 ft. long, and is provided with four powerful electric cranes, which will be supplemented by the latest scrap breaking machinery. It is interesting to note that the vessels come into the hands of the shipbuilders complete with all guns and fittings.

The *Orion* was laid down at Portsmouth in November, 1909, launched the following August, and commissioned in January, 1912 as the flagship of the second battle squadron. It carried ten 13.5 inch guns, and took part in the Battle of Jutland.

H.M.S. *Erin*, together with H.M.S. *Agincourt*, belonged to Turkey at the outbreak of war, and their taking over by the Admiralty is sometimes supposed to have a strong political significance. It was laid down at Barrow by Messrs. Vickers and commissioned for service on August 22, 1914. Like the *Orion*, it carried ten 13.5 inch guns and took part in the Battle of Jutland. The total normal displacement of the two boats is 45,500 tons. The provision of large quantities of steel scrap will be welcomed by the market, as there has been some shortage recently occasioned by very heavy German buying, some of which is reported as being returned to this country. This venture of Messrs. Cox and Danks has been augmented by the opening of warehouse and stockyard accommodation, at 170 to 174, Attercliffe Road, Sheffield. Increased activity is also expected at their Cradley Heath depôt.

The cutting up of armour plate entails considerable difficulties. Armour plate is made from a nickel-chromium steel, which is comparatively low in carbon. The cementation of the surface is accomplished by placing it on a large-wheeled bogie wagon, which on entering the furnace forms its hearth. The plate is covered by a predetermined amount of animal charcoal and is covered by a second plate. This enormous "sandwich" is fired and the surface for two or three inches is highly carburised. The plates on removal from the furnace are opened out and quenched on the carburised face. This gives a glass-hard surface which is only "starred" by impact with a projectile, the relatively soft and tough backing preventing the smashing of the plate.

Though Queenborough is for the moment more or less isolated, this is not being allowed to hamper the work of breaking up, traffic being maintained by shipping. The work will find much regular employment for the local unemployed.

THERE WERE ONLY 40 vessels launched on the Tyne last year with a total of 147,000 tons, little more than one-half of the previous year.

Trade Talk.

MR. J. E. STEWART, engineer, has opened an office at Castle Buildings, Llanelly.

H. SIBILLE & COMPANY, LIMITED, have removed to 70, Victoria Street, Westminster, London, S.W.1.

THE YORKSHIRE COPPER WORKS, LIMITED, of Leeds, have established a branch office at 53, New Broad Street, London, E.C.2.

THOS. H. HOWELL, LIMITED, iron and steel merchants, of Newport, Mon., have opened an office at 65, Fenchurch Street, E.C.3.

DRAKE & GORHAM, LIMITED, announce that about half of the issue of £50,000 10 per cent. seven-year notes have been drawn for repayment on May 7, 1923.

VICKERS, LIMITED, are in receipt of an order from the British Government to recondition 4.7 guns which during the war were mounted on merchant craft.

MR. C. H. WORDINGHAM, consulting engineer, of 7, Victoria Street, London, S.W.1, has removed his Manchester offices from 11, Mosley Street, to 33, Brazenose Street.

THE COMMONWEALTH EDISON COMPANY, of Chicago, have placed an order with C. A. Parsons & Company, Newcastle-on-Tyne, for a turbo-alternator of 40,000 kw., or about 55,000 h.p.

LICENCES UNDER THE Non-Ferrous Metal Industry Act (1918) have been granted to Glasgow Merchants, Limited, Glasgow, Milner Brothers, Limited, London, and H. Zabban, London.

THE CONSIDÈRE CONSTRUCTION COMPANY, LIMITED, of Victoria Street, Westminster. London, S.W.1, will in future carry on business under the style of Considère Constructions, Limited.

THERE was an outbreak of fire recently in the steel moulding shed at the works of Dobson and Barlow, Limited, Bolton. The fire, however, was subdued before extensive damage was done.

JOHN BAKER AND SONS, LIMITED, of Rotherham, have received an order from the East India Railway Company for 2,300 pairs of broad-gauge wheels and axles with rolled steel disc centres.

DR. DESCH, of Sheffield University, at the monthly meeting of the local section of the Institute of Metals, held in Armstrong College, Newcastle, on Tuesday, lectured on "Plastic Flow in Metals."

MR. W. A. GILLOTT read a paper on January 9 to the members of the Scottish centre of the Institution of Electrical Engineers on "Domestic Load Building." Mr. J. A. Hampton occupied the chair.

CARRICK AND BROCKLEBANK, LIMITED, 13, Chapel Walks, Cross Street, Manchester, and Aitken Chambers, Cannon Street, Birmingham, have been appointed agents in the Lancashire and Birmingham areas for Pease and Partners, Limited.

AN ACCIDENT OCCURRED to a large generator which was undergoing a test on January 10 at the works of the General Electric Company, Limited, Witton, Birmingham, and a number of workpeople were injured by flying pieces of metal, two seriously.

MR. C. K. EVERITT, a director of Messrs. Edgar Allen & Company, Limited, delivered his presidential address before the Sheffield Society of Engineers and Metallurgists last Monday. He took for his subject "Some Achievements and Probable Lines of Progress in the Manufacture of Steel."

SHAREHOLDERS of the National Boiler & General Insurance Company, Limited, have accepted the offer of the Alliance Assurance Company to acquire National Boiler shares for a cash payment of £50 per share, with a final dividend for the past year of 20s. per share, less tax, making 32s. per share.

J. BLAKEBOROUGH & SONS, LIMITED, have recently secured a large contract for the supply of various sluice, disc and reflux valves, also a large number of fire hydrants, for the Argentine Government. It is interesting to note that this order was obtained in the face of both German and American competition.

PREPARATORY OPERATIONS WILL commence at once at the old Pembrey Copper Works site, recently acquired by Frickers Metals, Limited, when a large number of men will be employed. The new firm have a considerable undertaking at Luton, and it is stated that the promoters will, as soon as trade revives sufficiently, carry out extensive operations at Burry Port.

IN CONNECTION WITH the extension of the Hampstead line from Golders Green to Edgware, the Underground Company have placed a contract with Sir Wm. Arrol and Company, Limited, of Bridgeton, Glasgow, for a steel bridge at Queen's Road, Golders Green, and steel bearings for the bridges of Elm Croft Crescent, Woodville Road, Highfield Avenue, and Shirehall Lane.

HENRY BATH & SON, LIMITED, metal merchants, 53, New Broad Street, London, E.C.2, owing to the expiration of the lease, will be unable to store metals, minerals, etc., at the North Dock, Swansea. Mr. J. W. Williams, resident director, has retired, together with Mr. M. J. Langdon, but the Swansea business will be carried on by Mr. H. Roswell Brown and Mr. T. Lane, under the direction of the London office.

BEFORE the Wolverhampton branch of the Birmingham Metallurgical Society, on January 10, a lecture was given on "Tool Steel" by Mr. F. C. A. H. Lantsberry, who is connected with a well-known Sheffield firm. The lecture was of a popular character, and concluded with a film exhibition of actual operation in a large Sheffield establishment. The chair was taken by Mr. L. Nettleton, the chairman of the branch.

THE IRON-ORE GRABS which were introduced by the Clyde Trustees some time ago for discharging minerals at the harbour have been so successful that they are now being put in operation at all the docks and quays where this class of cargo is handled. It is stated that one set of these grabs can discharge up to 400 tons of iron ore in an eight-hour shift, with six men in attendance. Under the old conditions a squad of nineteen men might average 200 tons in the same time.

NEW WORKS IN course of erection at Crumlyn Burrows, Swansea, are likely to add very substantially to the industrial development of the district. The bridge and structural engineering works of Sir William Arrol and Company (Swansea), Limited, occupy a site of about twelve acres, and though their construction only began last June, they are already commencing to manufacture, and it is hoped they will soon find employment for 500 men, in addition to those who will be engaged in erections for outside contracts.

Personal.

THE LATE MR. A. T. JENNINGS, machinery merchant, of Manningham, Bradford, left £11,561.

CAPTAIN A. C. BURGOINE, lately of the Directorate of Research at the Air Ministry, has joined the staff of Lodge Plugs, Limited.

MR. W. L. LISMER has been admitted as a partner in the firm of E. W. Neems & Company, metal brokers and merchants, of 11, Fenchurch Street, London, E.C.3, and Birmingham.

MR. G. HAIGH, of North Cliffe, Cleckheaton, left his house on Friday last to go to the works of Hodgson Hartley, Limited, engineers, of which firm he is a director, but he has not been seen since.

MR. W. HOWARD WADMORE has resigned his position with the Metropolitan Vickers Electrical Company, Limited, Trafford Park, Manchester, to take up an appointment with the A.C.E.C., 56, Victoria Street, London, S.W.

MR. W. S. VAUGHAN, chairman of the Blyth Shipbuilding and Dry Docks Company, Limited, has resigned. Sir Walter Runciman, Bart., has been elected chairman, and Mr. R. M. Sutton has been elected to fill the vacancy on the board of directors.

MR. W. A. SYCAMORE has been appointed manager of the London branch, at Albion House, New Oxford Street, W.C.1, of the Keighley Gas & Oil Engine Company, Limited, Dalton Lane, Keighley, in succession to Mr. H. S. Aspinall, who has resigned his position.

THE RIGHT HON. SIR ROBERT HORNE, K.C., M.P., has been elected a director of the Great Western Railway Company to fill the vacancy on the board caused by the death of Mr. J. G. Griffiths. Soon after his retirement from the post of Chancellor of the Exchequer, Sir Robert Horne joined the board of Baldwins, Limited, and the British Mannesmann Tube Company, Limited. He sailed for the United States on January 10.

Luossavaara-Kirunavaara A.B.—An agreement has been concluded between the Swedish Luossavaara-Kirunavaara Aktiebolag, and their workers numbering 3,000 at the Kiruna, Malmberg and Svartoen iron mines, involving a reduction of wages by eight to nine per cent.

Hauts Fourneaux de la Chiers.—This Franco-Belgian concern reports for the financial year ended September 30, 1922, profits totalling 4,260,551 fcs. (say, £66,550), as compared with 925,960 fcs. in the previous year. The name of the company is just now much in the public eye, as its refusal to submit to the ruling of the French Comptoir Sidérurgique has led to the dissolution of this Comptoir.

Deaths.

MR. T. J. DAVIES, J.P., of Morriston, died at his residence, Morfydd, Morriston, last week. Mr. Davies was a director of the Worcester and Upper Forest Tinplate Works. He sat for a period (like his brother) in the Swansea County Borough Council, he was a county magistrate, and he acted as high sheriff of Glamorgan a few years ago. He was 57 years of age.

MR. AMBROSE FIRTH, the chairman of the Brightside Foundry & Engineering Company, Limited, Sheffield, died at Bournemouth, where he had resided during the past two years, on December 11. He was in his 78th year. Mr. Ambrose Firth was born at Grimesthorpe in 1845, and in his early days was associated with John Stanley at the Foundry, Brightside. In 1865, when only 19 years of age, he commenced business on his own account as an iron founder in a field near the River Don, the site of which is now covered by Messrs. Vickers works. From such small beginnings the well-known firm of the Brightside Foundry & Engineering Company, Limited, has grown to its present proportions. In those days the casting of a 20-ton hammer block was an event in the industry, but about a year ago a record casting weighing about 112 tons was made. After a few years Mr. Firth found the small foundry quite inadequate, and he acquired larger premises in Newhall Road, and the old Newhall Running Grounds. The extent of the new ground and premises allowed of considerable development of the business, but it was not very long before the concern had outgrown the accommodation, and Mr. Firth had again to look for more room. Eventually the Carbrook Works and the Wicker Iron Works, in the vicinity of the Wicker Arches, were established by the firm. The business continued to grow, and Mr. Firth put all his energy into the undertaking, which was by this time one of the leading industrial concerns of the city. He purchased in rapid succession several works and absorbed them into the Brightside Foundry & Engineering Company. These included J. C. & J. S. Ellis, heating and ventilating engineers, London; James France Hill's London heating business; Clayton Howlett & Company (manufacturers of brick making machinery), of London; and Hunter & Middleton, of London, also makers of brick making machinery. In 1899 Mr. Firth purchased Walker Eaton & Company's business (ironfounders and engineers), and recently added John Robinson (Royds Foundry), Moorwoods, Limited, engineers, etc., of Brightside, and Pullan & Mann, of Leeds, manufacturers of brick making machinery. Although so busily occupied with his own firm, Mr. Firth was also connected with other business enterprises, being a director of W. Cooke & Company, of Tinsley, and chairman of the Hathersage Gas Company.

Gazette.

MR. L. AMATO, Friendly Street, late 25, Brookmill Road, Deptford, engineer, has been adjudicated a bankrupt. Exam., C.C., Greenwich, February 20, at 11.

TRADING under the style of Greenwood & Trott, Messrs. E. Greenwood and S. G. Trott, Byram Street, Huddersfield, weighing machine makers, have dissolved partnership. Debts by Mr. S. G. Trott.

TRADING under the style of Carter & Company, Messrs. J. H. Carter and F. Carter, 37, Manchester Road, Nelson, electrical and mechanical engineers, have dissolved partnership. Debts by Mr. F. Carter.

THE COMMERCIAL ENGINEERING COMPANY, LIMITED.—A resolution has been passed and confirmed that the company should be voluntarily liquidated. Mr. J. H. Melrose, 41, Shrewsbury Road, Forest Gate, has been appointed liquidator.

TRADING under the style of the Boot Machinery & General Engineering Company, Messrs. J. T. Parish, W. Baker and E. Norman Wilson, Towlers Court, Elm Hill, Norwich, general engineers, have dissolved partnership. Debts by Mr. J. T. Parish.

SCOTTISH ENGINEERING CORPORATION LIMITED.—It has been resolved and confirmed:—That the company be wound up voluntarily. Mr. A. N. Maclaurin, 142, St. Vincent Street, Glasgow, C.A., has been appointed liquidator.

TRADING under the style of A. O. Farrington & Company, Messrs. A. E. Farrington, O. W. Farrington and W. T. Perrens, Wood Street, Willenhall, brass founders, have dissolved partnership. Debts by Messrs. A. E. Farrington and O. W. Farrington, who continue the business.

Company News.

Cooper & Hall, Limited, 23, Carter Lane, London, E.C.—Capital £20,000 in £1 shares. Steel manufacturers.

E. S. Moore, Limited.—Capital £2,000 in £1 shares. Mechanical engineers. Directors: W. H. Harlow and E. S. Moore.

Siemens Bros. & Company, Limited.—Dividend for half-year to December 31, 1922, on preference shares deferred until completion of audit.

Gwynnes Engineering Company, Limited.—Written off for depreciation, etc., £21,911; loss, £126,658; debit balance carried forward, £478,545.

Elliott's Metal Company, Limited.—Interim dividends, 5 per cent. per annum on preference for six months, and 1s. per share on ordinary.

Fred Townend & Company, Limited, Albion Works, Acton, London, W.—Capital £12.000 in £1 shares. Engineers. Directors: F. Townend and R. W. Miles.

F. S. Blackall, Limited, 2, Gresham Buildings, Basinghall Street, London, E.C.2.—Capital £100. Civil, mechanical, marine and electrical engineers, etc. Permanent directors: F. S. Blackall and F. W. G. Snook.

Henry Hargrave & Sons, Limited, Manchester Road, Millwall, London, E.—Capital £20,000 in £1 shares (5,000 preference and 15,000 ordinary). Iron, steel and machinery merchants, etc. Directors: H. T. Hargrave (permanent managing), H. A. Hargrave, W. A. Hargrave, H. S. Lambert and W. A. J. Tilleray.

Skeldings, Limited, 126, Oldbury Road, Smethwick, Staffs.—Capital £5,000 in £1 shares, to acquire the business of a manufacturer carried on by E. Skelding as Ward, Skelding & Company, and also the business of general engineers and machinists carried on by V. A. Fisher, F. Enderbury and J .T. Baker as the Corser Manufacturing Company.

H. Sibille & Company, Limited, 70, Victoria Street, Westminster, London, S.W.1.—Capital £11,000 in £1 shares (7,000 ordinary and 4,000 10 per cent. participating preference), to acquire the business of dealing in iron and steel railway material, engineering and contractors' plant, etc., carried on by H. Sibille & Company at 15, Dartmouth Street, Westminster. Directors: H. A. Sibille (managing) and J. P. Bate.

Contracts Open.

King's Lynn.—Supply of about 600 yards of 8-in. diameter cast-iron or steel mains, also various specials. Engineer, Gas Company, King's Lynn.

London, S.W., January 26.—Supply of pig-iron, for the Bombay, Baroda and Central India Railway Company, 91, Petty France, Westminster, S.W.1. Mr. S. G. S. Young, secretary. (Fee, 10s., non-returnable.)

Dublin, February 2.—Supply of bullhead rails, flat-bottom rails and fishplates of British standard sections, also cast-iron chairs and fastenings, for the Great Northern Railway of Ireland Company. Mr. J. B. Stephens, secretary, Amiens Street Station, Dublin.

Messrs. Gibbons, Skinner and Company, 30, Wharf Road, City Road, London, N.1, have sent us their January price list for galvanised goods.

Small Electric Furnace Regulation.—The difficulty experienced by operators in adjusting the arcs of small electric furnaces not having automatic control is discussed by MR. C. E. SIMS (electrometallurgist), of the United States Bureau of Mines, in extracts of reports on investigations into this subject, Serial No. 2411. He suggests connecting two 40-watt incandescent lamps in series between the two electrodes of a single-phase furnace. The centre point of the series is connected to the furnace shell, but if that is unworkable a steel bar can be buried in the hearth similar to the bottom electrode of a Girod furnace. In operation the brilliancy of the filament of either lamp will vary with the drop in potential between the electrode and the bath. When power is on and no arc has been drawn, the lamps will simply be in series across the bus bars, and will glow with equal brilliancy. When current is flowing through the furnace they are lighted equally only when both arcs are exactly the same, that is, have the same length and, therefore, the same resistance. The slightest change in either arc is quickly and accurately indicated by the lamps. If one electrode should touch the bath its pilot light would instantly go black. To instal this apparatus for three-phase operation it is necessary merely to add one more lamp. So far as the author is aware, this simple arrangement is original.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH. — The revival of market activity in Cleveland iron anticipated in previous reports has been strongly in evidence in the past week or so, accompanied, as was also expected, by a distinct upward tendency in prices, to the disappointment of consumers, who have been delaying buying in the hope of obtaining easier terms in the new year. There is consequently now a movement to secure deliveries over the next few months at prices current, which makers, however, are disinclined to favour, in the face of a prospective further advance in fuel costs, making it impossible to fix up coke contracts on terms justifying sales of pig-iron on anything like present values. In the meantime there is now no question that home demands are steadily increasing, while outputs at furnaces are still comparatively limited, and as the cost of running plants is on an advancing scale, there seems at the moment little inducement to smelters to enlarge the scope of their operations. Export business on Tees-side has, of course, been affected by the disturbed political situation on the Continent, but it is regarded as possible that ultimately there may be an increase of buying in that direction, the existing shortage of fuel in European countries having been naturally aggravated by passing events in the Ruhr area. Current quotations for Cleveland iron are firmer all round, ruling about as follow: No. 1, 105s.; No. 3 G.M.B., 100s.; No. 4 foundry, 95s.; and No. 4 forge, 90s. per ton.

The Tees-side hematite market continues strong and active, and quotations show a further upward move. The home demand continues to broaden out as trade in the consuming industries expands, and it is possible that export business may be, at least temporarily, improved in some measure by the present situation on the Continent. During the last few weeks a moderate amount of business has been passing with Italy, but British exporters have been handicapped by the competition of cheap German material. Meanwhile, quotations show an advancing tendency, but are rather irregular, varying, for East Coast mixed numbers, from 95s. to as much as 97s. 6d. per ton. But an average quotation would be about 96s., with an additional 6d. per ton for No. 1. On the North-West Coast outputs of hematite iron are fully absorbed by home demand, with prices steady at 107s. 6d. to 110s. per ton for Bessemer mixed numbers.

SCOTLAND.—Buying in Glasgow market last week was reported on a more active scale, fair tonnages of Cleveland iron for delivery over the next few months changing hands at 98s. 6d. f.o.t. Falkirk, but some cheaper Continental pig was obtainable at 92s. 6d. per ton. Malleable consumers are experiencing an improvement in demand, and have been buying some Middlesbrough forge at 91s. 6d. per ton at Coatbridge, whilst for No. 4 Scotch they have to pay about 2s. 6d. per ton more. The anomalous position thus arises of No. 3 Middlesbrough being about 5s. per ton dearer than No. 3 Scotch, whilst forge Middlesbrough is 2s. 6d. per ton cheaper than Scotch forge.

THE MIDLANDS. — In common with other markets for pig-iron, price movements in the Midlands have also shown an upward tendency, quotations having stiffened to about 2s. 6d. per ton. As a general rule smelters report that they have made quite good sales, and some of them have done so well that they have nothing further to offer for delivery this quarter, and at present are not inclined to sell still farther ahead except at prices which will cover any possible increase in production costs. The improvement in demand experienced extends to both forge and foundry qualities.

MANCHESTER.—Local demand for foundry pig is again increasingly active, and buyers are now freely contracting for deliveries extending over May and even into June. Some makers are talking of higher prices, and the estimate is that for Derbyshire No. 3 the quotation should be based on 85s. per ton at the furnaces, especially as the rise in coke has added to the cost of making the iron. It is also claimed by the Derbyshire and Midland makers generally that it is unjust that they should be selling their iron at 10s. less than is being obtained by the Cleveland makers. It is not likely, however, that in any case the Midland makers will try to get their prices up above 85s. on trucks, even although Cleveland iron of the same quality should still be selling at 92s. on trucks. It is reported that the makers of Northamptonshire iron, who have for a long time been selling their No. 3 foundry iron at 80s. on trucks, are now insisting upon 82s. 6d.

Finished Iron.

Manufacturers of finished material, although by no means fully employed, are now enabled to maintain a fairly steady output, with order books on forward account more satisfactorily situated than has been the case for a long time past. This improvement in conditions was a distinct feature of the business transacted at Birmingham last week, where the retention of the standard value of marked bars was decided upon without surprise. As a matter of fact, the £13 10s. basis for bars has been steadily maintained throughout the depression, while other qualities have been falling so that there was no leeway to make up. The advance of 10s. in crown iron was rather larger than was expected, but in view of the unremunerative nature of the prices which have been ruling for many months it was not really surprising. It extends to Lancashire and North Staffordshire crown bars as well. Makers in South Staffordshire report that they are much better sold forward than they have been for a long time, and under such circumstances can afford to hold out for a price which will afford them some profit.

Scrap.

The improvement previously reported in scrap metal conditions is fully maintained, and in view of the advancing prices for pig-iron and other raw material is regarded as likely to be further enhanced by an increased demand in the near future. At Sheffield, for example, the interest in the scrap market is greater than ever, and the shortage of melting steel is now pronounced. For heavy material of the best quality it is reported that as much as 10s. over the quoted price of 75s. delivered has been paid, but any buyer who has given this figure must have been hard pushed to secure supplies. There does not seem to be much question, however, that up to 80s. has been paid. It is stated that very little scrap of any kind is now going out of the country, even the poorest quality being no longer a drug in the market. There is a fair lot of business doing in iron scrap, the feature in this district being heavy wrought material. In Scotland, also, bundled materials are also increasing in value, and holders are now prepared to sell small quantities. As in the case of other materials, however, they will only commit themselves to the extent of stocks they have actually got on hand, and this limits transactions considerably. First quality bundles are quoted 77s. 6d., second quality about 72s. 6d., and bundled iron 67s. 6d. The demand for all classes of cast-iron scrap shows a marked improvement, but, as in all other cases, supplies are not as satisfactory as might be desired. Heavy machinery metal and scrap railway chairs run about 87s. 6d., and ordinary cast-iron scrap 82s. 6d. Light metal and furnace firebars are at 63s. 6d.

Steel.

Conditions in the steel industry, which have been consistently improving for some time past, continue satisfactory in most departments, increased activity being marked in the demand for engineering, constructional and shipbuilding requirements, while the trade in semi-products is also on an expanding scale. In the last-named section the volume of business in basic billets in Sheffield is now not much greater proportionately than in acid qualities, for which there is a pretty satisfactory demand at present. Crucible steel is in better demand, but has not yet reached its old-time output figures. Electric steel production shows weekly improvement. Two or three more local Siemens steel furnaces are about to be put into commission, and shortly production will be up to about two-thirds of capacity. Railway steel is very firm, and the demand for tool steels is a gratifying feature. In the ferro-alloy market interest is still maintained in 10 to 12 per cent. ferro-silicon, in which grade further inquiries of a fair size are about. The price works out at round about £8 per ton f.o.r., according to Si. content. Ferro-manganese and spiegel for home consumption remain steady with prices unchanged. There is a little interest being taken in silico-spiegel, but silico-manganese is quite dull with the price maintained round about £16 per ton for the 50/55 manganese content grade. The tinplate market continues active, most makers being now well booked up to the end of March, and holding firmly for prices delivery beyond that period. At a meeting of the Stabilisation of Prices Committee it was decided to raise the

IRON AND STEEL MARKETS,—*Continued.*

minimum price to 20s. 6d. per standard box, which figure has previously been paid by some buyers for forward delivery. For the time being, therefore, steel cokes, 14 by 20, will be quoted at 20s. 6d. per box minimum, 28 by 20 at 41s., 18¾ by 14 oils at 21s., and 20 by 10 primes at 29s. 10½d.

Metals.

Copper.—The unsettled political outlook on the Continent has naturally had an adverse influence on metal market conditions, with an equally depressing effect upon values, which have declined to lower levels. In the standard copper market buying has been on a restricted scale, both for home consumption and on foreign account, while speculative business has also been subdued in volume. A factor contributing weakness to the market has been the easier tendency of electrolytic in America, while the firmness of the sterling exchange has not made for any improvement. The position as regards manufactured copper is better, while more business from India for sheets and yellow metal has been placed. The contango has now shrunk to about 12s. 6d., a feature of the market that is ascribed to the cheapness of money. Current quotations:—*Cash*: Wednesday, £63 7s. 6d.; Thursday, £63 10s.; Friday, £63 10s.; Monday, £64; Tuesday, £64 15s. *Three Months*: Wednesday, £64; Thursday, £64 2s. 6d.; Friday, £64; Monday, £64 12s. 6d.; Tuesday, £65 5s.

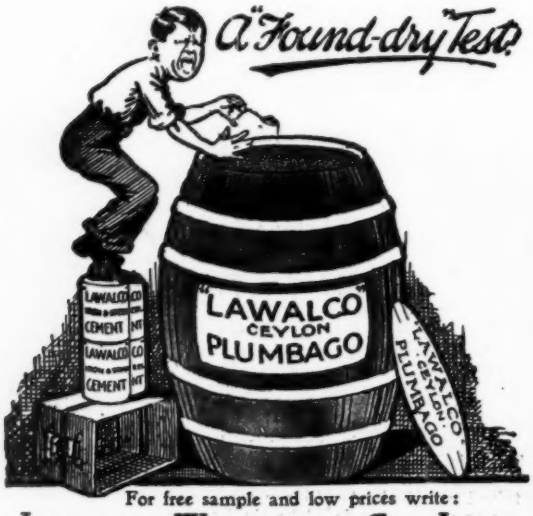
Tin.—Business in the standard tin market during the past week has been without outstanding features of interest, although buying by home consumers has been fairly regular, with quotations showing little variation, fluctuations being confined within a very narrow range. On speculative account there is more disposition to buy than to sell, and it is to this that may be ascribed the fact that values have been comparatively well maintained. The tinplate makers in South Wales appear to be very well off for orders, so that a more satisfactory outlook as regards the demand from that quarter may be assumed. Exports of tin from the Federated Malay States during December are officially stated to have amounted to 3,144 tons, as compared with 2,867 tons in November and 3,435 tons in the corresponding month of 1921. The approximate total export of tin for the past year amounted to 35,288 tons, as against 34,490 tons in 1921 and 34,934 tons in 1920. Current quotations:—*Cash*: Wednesday, £180 12s. 6d.; Thursday, £180 7s. 6d.; Friday, £181 2s. 6d.; Monday, £182 2s. 6d.; Tuesday, £183 15s. *Three Months*: Wednesday, £182 5s.; Thursday, £182; Friday, £182 15s.; Monday, £183 15s.; Tuesday, £185 5s.

Spelter.—Conditions in the spelter market continue quiet, but prices remain consistently steady, with mostly a slightly upward tendency. Messrs. Rudolf Wolff & Company report that consumers here have bought only sparingly, but should shortly be in the market on a more extensive scale. On the Continent there has been a little more disposition to sell, but there is no actual weakness; nor is there indication of any appreciable surplus accumulating. Current quotations:—*Ordinary*: Wednesday, £35 7s. 6d.; Thursday, £35 12s. 6d.; Friday, £35 12s. 6d.; Monday, £35 10s.; Tuesday, £35 8s.

Lead.—The market for soft foreign pig has evidenced a somewhat weaker tendency of late, but conditions remain comparatively firm. Stocks are stated to be at a very low level, and undoubtedly there is a modicum of truth in this statement, but too much stress is laid upon this apparent shortage. Supplies coming into the country appear to be quickly and easily absorbed, and certainly this is so, but not by the consumptive demand. Current quotations:—*Soft foreign (prompt)*: Wednesday, £26 10s.; Thursday, £26 10s.; Friday, £26 7s. 6d.; Monday, £25 10s.; Tuesday, £27.

Titanium as a Steel Alloy.

The use of titanium as an alloying element for steel is much shrouded in secrecy. According to information supplied to the Bureau of Mines, carbon-free ferro-titanium has been employed in Europe for making an electric steel containing 5 to 7 per cent. titanium. Rumours of the use of titanium-alloy steels for armour-plate have been circulated, but so far as is known to the Bureau, no merit has been found in the addition of titanium to steel as an alloying element, and experiments with steels containing 0.1 to 1.0 per cent. titanium have shown no special advantages. A more interpretative investigation than any so far carried out is required to distinguish more clearly the merits of titanium-alloy steels, and it must be assumed now, pending exact proof to the contrary, that these steels are of no particular value, or at least yield no advantages not provided by other steels. It is rather difficult to get the carbon-free ferro-titanium to alloy with steel without much loss of titanium, and this fact, coupled with the high price of the carbon-free alloy, has tended to discourage experimentation by steelmakers in this direction. It is possible, however, that if the cost were less, some combination of titanium, either alone or with other metals, might produce valuable steels for some purposes, and experiments need to be carried out. Titanium increases the hardness of steel, and experiments on titanium steels have been made by Guillet, Braun, and Lamort. It has been shown recently by Gillet and Mack in Bulletin 199 of the Bureau of Mines that fair recoveries may be expected with carbon-free ferro-titanium, provided the alloy is added at the end of the heat and the steel is very hot. Complex iron-chromium-titanium alloys have been patented for use in making chromium steels—for example, 55 to 75 per cent. chromium, 5 per cent. titanium, 5 to 10 per cent. carbon, and 34 to 10 per cent. iron.



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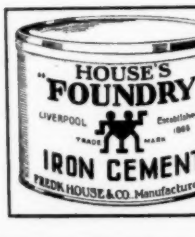

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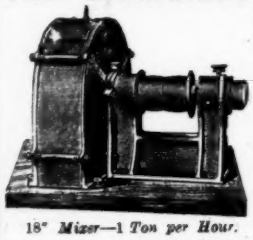
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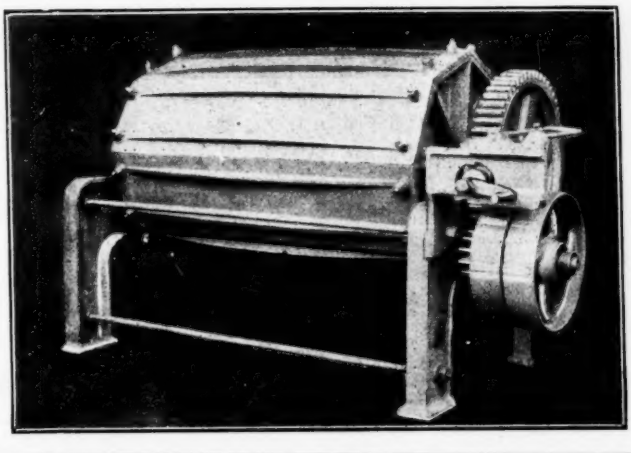

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Do. Mar.	71 5 0
Ingot bars	71 5 0
H.C. wire rods	75 10 0
Off. aver. cash, Dec. 63	6 9 9/10
Do. 3 mths., Dec. 64	2 9 1/10
Do. Settlement Dec. 63	5 9 9/10
Do. Electro, Dec. 70	6 3 1/10
Do. B.S., Dec.	67 10 0
Aver. spot price, copper, Dec.	63 5 9½
Do. Electro, Dec. 70	10 0
Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.
Yellow metal rods	6½d.
Do. 4x4 Squares	8½d.
Do. 4x3 Sheets	9¼d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extruded or rolled	6½d.
Sheets to 10 w.g.	10d.
Wire	9½d.
Rolled metal	9½d.

TIN.

	£ s. d.
Standard cash	183 15 0
Three months	185 5 0
English	183 15 0
Bars	185 15 0
Chinese	181 15 0
Straits	185 5 0
Australian	185 0 0
Eastern	187 15 0
Banca	185 0 0
Off. aver., cash, Dec.	178 15 6 6/10
Do. 3 mths., Dec.	180 0 3 1/10
Do. Sttlment, Dec.	178 18 3 3/10
Aver. spot, Dec.	178 14 2½

SPELTER.

	£ s. d.
Ordinary	35 5 0
Remelted	34 10 0
Hard	28 0 0
Electro 99.9	41 0 0
English	37 0 0
India	29 0 0
Prime Western	37 0 0
Zinc dust	49 0 0
Zinc ashes	11 0 0
Off. aver., Dec.	36 4 11 4/10
Aver., spot, Dec.	37 15 1½

LEAD.

	£ s. d.
Soft foreign ppt	27 0 0
English	28 5 0
Off. average, Dec.	25 15 9 9/10
Average spot, Dec.	26 1 7

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	44 0 0
Do. V.M. ex whf.	42 0 0
Dutch	42 0 0
Rods	49 0 0
Boiler plates	41 0 0
Battery plates	42 0 0

ANTIMONY.

	£ s. d.
English regulus	27 0 0
Special brands	33 10 0
Chinese	24 10 0
Crude	18 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	11 17 6
75%	20 10 0
Ferro-vanadium— 35/40%	17/- lb. va.
Ferro-molybdenum— 70/75% c. free	9/3 lb. mo.
Ferro-titanium— 23/25%, carbonless	1/1½ lb.
Ferro-phosphorus, 20/23%,	£23
Ferro-tungsten— 80/85%, carbon free	1/5 lb.
Tungsten metal powder— 98/99%	1/10½lb.
Ferro-chrome— 4/6% car.	£21 0
6/8% car.	£20 10
8/10% car.	£20 0
Ferro-chrome— Max. 2% car.	£54 0
Max. 1% car.	£65 0
Max. 0.70% car.	£73 0
67/70%, carbonless	1/6½lb.
Nickel—99%, cubes or pellets	£130 0
Cobalt metal—98/99%	11/3 lb.
Aluminium—98/99%	£95
Metallic Chromium— 96/98%	4/6 lb.
Ferro-manganese (net)— 76/80%, loose	£15
76/80%, packed	£16
76/80%, export	£14
Metallic manganese— 94/96%, carbonless	2/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	s. d. 2 6
Finished bars, 18% tungsten	3 0

Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.
Bevels of approved sizes and sections 6d. lb.
If in coils 3d.lb.
Packing £3 ton.
Bars cut to length 10% extra

Scrap from high-speed tool steel—
Scrap pieces 3d.
Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	4 5 0	4 10 0
Bundled steel & shearings	3 14 0	4 0 0
Mixed iron & steel	3 12 6	3 17 6
Heavy cast iron	3 15 0	3 17 6
Good machinery for foundries	4 0 0	4 5 0
Cleveland—		
Heavy steel	3 15 0	
Steel turnings	3 0 0	
Cast-iron borings	3 0 0	
Heavy forge	4 5 0	
Bushelled scrap	3 15 0	
Cast-iron scrap	3 17 6	
Lancashire—		
Cast-iron scrap	4 3 9	
Heavy wrought	3 15 0	
Steel turnings	2 15 0	

London—	£ s. d.
Copper (clean)	58 0 0
Brass (clean)	34 0 0
Lead (less usual draft)	23 0 0
Tea lead	20 0 0
Zinc	22 10 0
New aluminium cuttings	64 0 0
Braziery copper	49 0 0
Gun metal	44 0 0
Hollow pewter	150 0 0
Shaped black pewter	90 0 0

Above are merchants' buying prices delivered yard.

PIG-IRON.

N. E. Coast—	
Foundry No. 1	105/-
Foundry No. 3	100/-
Forge No. 4	90/-
Mottled	87/6
Hematite No. 1	98/-
Hematite M/Nos.	97/6
Midlands—	
Staffs. common	—
,, part-mine forge	—
,, ,, foundry	—
,, Cold blast, ord.	190/-
,, ,, roll iron	200/-
,, basic	—
Northants forge	75/-
,, foundry No. 3	82/6
,, basic	—
Derbyshire forge	80/-
,, foundry No. 3	87/6
,, basic	—
Scotland—	
Foundry No.1	100/- to 103/6
,, No.3	95/- to 98/6
Hematite M/Nos.	105/-
Sheffield (d/d district)—	
Derby forge	85/-
,, foundry No. 3	87/6
Lincs. forge	86/6
,, foundry No. 3	87/6
,, basic	86/6
E.C. hematite	104/3
W.C. hematite	108/9
All d/d in the district.	
Lancashire (d/d eq. Man.) —	
Derby forge	—
,, foundry No. 3	92/6
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
,, foundry No. 3	—
Summerlee foundry	111/-
Glengarnock foundry	114/6
Gartsherrie foundry	113/-
Monkland foundry	111/-

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.
Bars (cr.)	£10 10 to 11 10 0
Angles	£10 15 to 11 15 0
Tees to 3 united ins.	£11 to £12
Nut and bolt	10 2 6
Hoops	14 0 0
Marked bars (Staffs.)	13 10 0
Gas strip	11 0 0
Bolts and nuts, ¾ in. × 4 in.	16 10 0
Steel—	
Ship plates	£9 to 9 10 0
Boiler plates	13 0 0
Chequer plates	10 5 0
Angles	9 0 0
Tees	£9 12 6 to 10 0 0
Channels	8 10 0
Joists	9 0 0
Rounds & squares 3 in. to 5½ in.	11 0 0
Rounds under 3 in. to ⅝ in.	10 15 0
Flats, over 5 in. wide and up	11 5 0
Flats, 5 in. to 1½ in.	10 10 0
Rails, heavy	9 0 0
Fishplates	13 0 0
Hoops	11 0 0
Black sheets, 24 g.	11 15 0
Galv. cor. sheets, 24 g.	18 5 0 to 18 10 0
Galv. fencing wire, 8 g. plain	16 0 0
Rivets, ¾ in. dia.	11 15 0
Billets, soft	7 0 0 to 8 0 0
Billets, hard	8 0 0 to 8 15 0
Sheet bars	7 12 6 to 7 15 0
Tin bars	8 1 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 3
Sheet	1 3½
Wire	1 3½
Rods	1 2½
Tubes	1 6
Castings	1 1

Delivery 3 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4½ to 1/10½
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/- to 1/6
Wire round— 3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	29.76
No. 2 foundry, Valley	27.00
No. 2 foundry, Birm.	23.00
Basic	27.96
Bessemer	29.27
Malleable	28.96
Grey forge	28.27
Ferro-manganese 80% delivered	102.50
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	37.50
O.-h. billets	37.50
O.-h. sheet bars	37.50
Wire rods	47.50
	Cents.
Iron bars, Phila.	2.32
Steel bars	2.00
Tank plates	2.00
Beams, etc.	2.00
Skelp, grooved steel	2.00
Skelp, sheared steel	2.00
Steel hoops	2.75
Sheets, black, No. 28	3.35
Sheets, galv., No. 28	4.35
Sheets, blue an'l'd, 9&10	2.50
Wire nails	2.70
Plain wire	2.45
Barbed wire, galv.	3.35
Tinplate, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	35/- to 40/-
,, furnace	25/- to 27/6
Durham & North. fdy.	27/6 to 30/-
,, furnace	26/6
Other Districts, foundry	25/- to 30/-
,, furnace	25/6

SWEDISH IRON.

Bars, hammered basis sizes—Basis price £22 to £23

	£ s. d.
Rolled Ordinary—Assortment ..	17 10 0 to 18 5 0
Nail Rods—Square, round and flats ..	

Keg Steel nom. £38 to £40
Faggot Steel nom. £30 to £32

Blooms—
Single welded .. £10 to £11

Billets—
Single and double welded .. .. £13 to £14

Pig-iron—
Grey, white or mottled £6 10 to £7 5 0

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

Up to and incl. 6 in.

Gas ..	..57½%	Tube prices are now free.
Water	..52½%	
Steam	..47½%	

TINPLATES.

I.C.Cokes,	20×14, box	20/9
,,	28×20, ,,	42/–
,,	20×10, ,,	29/10½
,,	18¾×14, ,,	21/4½
I.X.	,,	47/6
I.X.X.	,,	53/6
F.C.B.Y.	21×13⅝ ,,	38/6
C.V.B.G.	16¾×15, ,,	36/6
I.C.W.	20×14, ,,	19/–
,,	28×20, ,,	38/–
,,	20×10, ,,	27/–
,,	18¾×14, ,,	19/3
Terneplates,	28×20, ,,	38/–

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£	s.	d.		
Jan. 17	63	7	6	dec.	2/6
,, 18	63	10	0	inc.	2/6
,, 19	63	10	0	No change	
,, 22	64	0	0	inc.	10/–
,, 23	64	15	0	,,	15/–

Electrolytic Copper.

Jan. 17	70	7	6	No change	
,, 18	70	12	6	inc.	5/–
,, 19	70	15	0	,,	2/6
,, 22	71	5	0	,,	10/–
,, 23	71	10	0	,,	5/–

Standard Tin (cash).

Jan. 17	180	12	6	dec.	5/–
,, 18	180	7	6	,,	5/–
,, 19	181	2	6	inc.	15/–
,, 22	182	2	6	,,	20/–
,, 23	183	15	0	inc.	32/6

Tin (English ingots).

Jan. 17	180	10	0	dec.	10/–
,, 18	180	10	0	No change	
,, 19	181	0	0	inc.	10/–
,, 22	182	0	0	,,	20/–
,, 23	183	15	0	,,	35/–

Zinc Sheets (English).

Jan. 17	43	0	0	No change	
,, 18	44	0	0	inc.	20/–
,, 19	44	0	0	No change	
,, 22	44	0	0	,,	
,, 23	44	0	0	,,	

Spelter (ordinary).

Jan. 17	35	7	6	inc.	5/–
,, 18	35	12	6	,,	5/–
,, 19	35	12	6	No change	
,, 22	35	10	0	dec.	2/6
,, 23	35	5	0	,,	5/–

Lead (English).

Jan 17	27	15	0	dec.	5/–
,, 18	27	15	0	No change	
,, 19	27	15	0	,,	
,, 22	27	15	0	,,	
,, 23	28	5	0	inc.	10/–

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
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Manufacturers of
FIRE BRICKS, BLAST FURNACE BRICKS & CUPOLA BRICKS.

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To all Specifications.

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BEST H. C. COPPER & BRONZE WIRE a speciality.

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IRON & STEEL SCRAP
COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM COLVIN & COMPANY,
ROYAL EXCHANGE, MIDDLESBROUGH.
93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

OF INTEREST TO FOUNDRIES POSSESSING NO LABORATORY.—Metallurgist and Foundry Chemist, who has specialised for the last twenty years in all classes of foundry practice, is open to act as Metallurgical Consultant and Chemist. Advertiser has own well-equipped Laboratory for undertaking the necessary Analytical work and Tests. Confidential work and moderate charges.—Write, Box 324, FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

LATE PRODUCTION MANAGER of well-known firm desires position; experience in Engine and Ordnance Work, Colliery and General Engineering.—Apply, W. LAING, 4, Main Road, Handsworth, Sheffield.

THE Lancashire Branch of the Institution of British Foundrymen beg to announce that several members, who have had varied experience as Foremen, etc., are at present disengaged. Employers who are in need of Foremen or other members of their foundry staff are invited to communicate with the Honorary Secretary, T. MAKEMSON, 21, Beresford Road, Stretford, Manchester.

AN EXPERIENCED FOUNDRYMAN, prepared to invest £1,000 on good security, seeks a responsible position in a going concern where his services as a practical man could be utilised at a fair remuneration.—Replies to Publishers, principals only, Box 326, FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—Assistant Manager for Steel Foundry, light and medium work; young and energetic, up-to-date knowledge of machine practice imperative; electric furnace practice an advantage but not essential.—State salary and experience, Box 320, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

ENERGETIC and capable young man wanted for Steel Foundry (Electric) in Scotland, as Technical Assistant to the Foundry Manager. Applicants, who should have some experience of general Steel Foundry practice, should give particulars of age, education, previous experience, salary required, when free, to Box 332, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED.—WORKING FOREMAN for Iron Jobbing Foundry now employing only 12 Moulders but with plenty of room for extension; must be used to machine tool work and familiar with best methods of plate, machine and jolt work; preference given to man who could introduce speciality; state wages and experience.—Box 322, FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

AGENCIES.

THE Manufacturers of the most up-to-date Moulding Machines in the world, who have over 16,000 Machines at work in the various Countries of the Universe, desire well-accredited and energetic Selling Agents in all British Colonies and Possessions for the sale of their Moulding Machines, and all Foundry Plant. In reply please write to THE UNIVERSAL SYSTEM OF MACHINE MOULDING & MACHINERY COMPANY, LIMITED, 97, Queen Victoria Street, London, E.C.4.

PATENTS.

INVENTORS Advice, Handbook and Consultations Free. KING'S PATENT AGENCY, LIMITED, Director, B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London; 36 years' references.

THE PROPRIETORS of the Patent No. 137,574 for Improvements in Steel Smelting Furnaces are desirous of entering into arrangements by way of licence and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country.—All communications should be addressed, in the first instance, to HASELTINE, LAKE & Co., Chartered Patent Agents, 28, Southampton Buildings, Chancery Lane, London, W.C.2.

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FOUNDRY SAND MIXERS (two), never been used, for 1 and 2 tons per hour; clearance prices.—Box 330, Offices of the FOUNDRY TRADE JOURNAL, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

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Ladle and Carriage (Stevenson's), having ladle 3 ft. 4 in. dia. at top, 2 ft. 8 in. dia. at bottom, 3 ft. 4 in. deep, 5 ft. gauge of carriage. 20 in. x 9 in. "Goodwin-Barsby" Stone Breaker, having "Era" manganese steel jaws. "Priestman" Single-chain Grab, 1 cub. yard capacity, four teeth to each bucket. Three "Peter's" Single-chain Grabs, each about ¾ cub. yard capacity. Perforated Grinding Mills, overdriven, 10 ft., 9 ft., and 7 ft. sizes. 3-ton "Avery" Dormant Weighing Machine, having platform 6 ft. x 4 ft. 3 in., and no-loose-weight steelyard. Set of "Krom-type" Crushing Rolls, 30 in. dia. x 15¾ in. wide, having manganese steel shells.

Catalogue of Stock Machinery, 6,000 Lots, Free on application. Inspection invited.

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FOR SALE, in splendid working order, one F. 4 Moulding Machine, by Universal System of Machine Moulding (Bonvillain et Ronceray); 150 pairs of moulding boxes, in steel, with or without bars, in conjunction with the above machine. Dimensions: 22 in. x 16 in. x 21/2 in., 65 lbs. per pair. One hydraulic pump and one accumulator, suitable for working six moulding machines, same make as above.—Address, ACIERIES DE MONS, Belgium.

COMPLETE New Portable Cutting Plant, £15 10s.; approval. Welding Plant, with six blowpipes, £22, including expert tuition at customer's works; approval. Cutting Blowpipes, unused, but soiled, £3; 1922 pattern.—STANSELL'S ACETYLENE COMPANY, LIMITED, Exeter.

NINE nearly new Steel Hopper Wagons, standard gauge, roller bearings.

Two sets of Belt-driven Geared Hydraulic Pumps, 2-in. rams and 4-in. rams.

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THREE 4 Cwt. capacity (single end)	£4 ,,
Hand Ladles	Ten at 12/- ,,

CRANE LADLES.

1 ton, not geared, by Evans	£18
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Every ladle and shank guaranteed serviceable and sent all ready to use.

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No. 2 Greens Cupolette with 480 Volt. D.C. blower, all in good order	£35
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